

SOMETHING IN THE AIR

The real reason the countryside is good for you

NewScientist

WEEKLY June 27 - July 3, 2015

A GLITCH IN TIME

WE'VE LOST CONTROL OF THE FOURTH DIMENSION

GOODBYE, RNA WORLD

A new view of the dawn of life

THE SKY IS FALLING
How scared should we
be of space rocks?

BRAIN IN FLAMES
The fevered origins
of depression

WHO'S THE MUMMY?
Busting the myth
of the gentle sex

Science and technology news

www.newscientist.com

US jobs in science

No 3027 US\$5.95 CAN\$5.95



After handshakes, we sniff people's scent on our hand



You won't believe you do it, but you do. After shaking hands with someone, you'll lift your hands to your face and take a deep sniff. This newly discovered behaviour – revealed by covert filming – suggests that much like other mammals, humans use bodily smells to convey information.

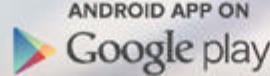
We know that women's tears transmit chemosensory signals - their scent lowers testosterone levels and dampens arousal in men. And that humans sweat and transmit

Free sample issues

See science everywhere

Enjoy free sample
issues within the app

Download the
New Scientist app today



#MakeThingsBetter
total.uk

COMMITTED TO SOLAR ENERGY

Total is the world's 2nd largest solar company with SunPower

 **TOTAL**
COMMITTED TO BETTER ENERGY

CONTENTS

News

8

The sky is falling

How scared should we be of space rocks?



SAM FURLONG/SWNS.COM

On the cover

28

A glitch in time

We've lost control of the fourth dimension

- 26 Something in the air Why the countryside is good for you
- 10 Goodbye, RNA world A new view of the dawn of life
- 8 The sky is falling Asteroid threat
- 38 Brain in flames Depression's origins
- 34 Who's the mummy? Myth of the gentle sex



Features

34

Who's the mummy?

Busting the myth of the gentler sex



RICHARD WILKINSON

Coming next week...

Dawn of Europe

Three tribes and how they built a continent

Cyber spooked

Is the world descending into cyberwar?

rbi reed business information

 **recycle**
When you have finished with this magazine please recycle it.

Volume 226 No 3027

This issue online
newscientist.com/issue/3027

Leaders

- 5 Sexism isn't just bad for scientists - it hurts science, too

News

6 UPFRONT

Taylor Swift bruises Apple. No Grexit, but Eurozone remains unstable. Extinctions soar. Weedy evidence for medical marijuana

8 THIS WEEK

RNA world never existed. Key steps in evolution of multicellular life recreated. Slowing climate change can boost health. Lava lakes keep Venus youthful. Messy humans won't spoil Mars

16 IN BRIEF

Malaria detected through the skin. Hairy backs are cool for Saharan ants. The sun stole a mini-planet

Technology

- 18 How to stop the ISIS propaganda machine. Automatic facial recognition in the street

Aperture

- 22 Dazzling flash of a woodpecker's wings

Opinion

- 24 A green pope Welcome the pontiff to the fight for climate action, say three academics

- 24 Screen it out Jamais Cascio on the scary possibility of a mute button for real life

- 25 One minute with... Cinzia Fantinati Philae's manager on future comet discoveries

- 26 Not just fresh air There is a toxic reason for the benefits of countryside, says Mike Moore

Features

- 28 A glitch in time (see above left)

- 34 Who's the mummy? (see left)

- 38 Brain in flames The fevered origins of depression

CultureLab

- 42 Big data's blueprint In the 1900s, America probed its citizens' lives as never before

- 43 Unjust Can science fix our legal system?

- 44 Knotty tale Saving seabirds is tough going

Regulars

- 54 LETTERS When microbes fight back

- 56 FEEDBACK Foot-in-mouth disease

- 57 THE LAST WORD Insect impostor

Morning pick me up



Lasting pick me up



**Subscribe for
less than \$2 per week**

Visit newscientist.com/8032 or call
1-888-822-3242 and quote offer 8032

NewScientist

LOCATIONS

USA

225 Wyman Street,

Waltham, MA 02451

Please direct telephone enquiries to our UK office +44 (0) 20 7611 1200

UK

110 High Holborn,

London, WC1V 6EU

Tel +44 (0) 20 7611 1200

Fax +44 (0) 20 7611 1250

Australia

Tower 2, 475 Victoria Avenue,

Chatswood, NSW 2067

Tel +61 2 9422 8559

Fax +61 2 9422 8552

SUBSCRIPTION SERVICE

For our latest subscription offers, visit newscientist.com/subscribe

Customer and subscription services are also available by:

Telephone 1-888-822-3242**Email** subscribe@newscientist.com**Web** newscientist.com/subscribe**Mail** New Scientist, PO Box 3806, Chesterfield, MO 63006-9953 USA

One year subscription (51 issues) \$154

CONTACTS

Contact us

newscientist.com/contact

Who's who

newscientist.com/people

General & media enquiries

enquiries@newscientist.com

Editorial

Tel 781 734 8770

news@newscientist.comfeatures@newscientist.comopinion@newscientist.com

Picture desk

Tel +44 (0) 20 7611 1268

Display advertising

Tel 781 734 8770

displaysales@newscientist.com

Recruitment advertising

Tel 781 734 8770

nssales@newscientist.com

Newsstand

Tel 212 237 7987

Distributed by Time/Warner Retail

Sales and Marketing, 260 Cherry Hill

Road, Parsippany, NJ 07054

Syndication

Tribune Content Agency

Tel 800 637 4082

© 2015 Reed Business Information Ltd, England.

New Scientist ISSN 0262 4079 is published weekly except for the last week in December by Reed Business Information Ltd, England.

New Scientist at Reed Business Information, c/o Schnell Publishing Co. Inc., 225 Wyman Street, Waltham, MA 02451.

Periodicals postage paid at Boston, MA, and other mailing offices. Postmaster: Send address changes to New Scientist, PO Box 3806, Chesterfield, MO 63006-9953, USA.

Registered at the Post Office as a newspaper and printed in USA by Fry Communications Inc, Mechanicsburg, PA 17055.



PAUL BRADBURY/GETTY

Unwelcome in the lab

Sexism isn't just bad for scientists. It hurts science too

TWO weeks after Nobel-winning biologist Tim Hunt characterised female scientists as lachrymose romantics, his downfall is still making headlines. Assorted luminaries have taken to the newspapers to argue that Hunt's punishment is disproportionate to the offence. His critics, mostly mobilised online, are unmoved.

Hunt's comments were crass, made as they were at a meeting about women in science; and insulting to many who promptly learned of them via social media. It's no defence to say they were merely a bad joke; any comic knows that if you are going to give offence, you had better be very funny. Freedom of speech might be a serious concern if Hunt had made a coherent, if unpopular, point about gender relations in the lab. Dignify his remarks with proper scrutiny, however, and they fall apart (see page 56).

The Hunt affair has other disquieting aspects. It is a reminder of how a social media frenzy can deprive its targets of natural justice. Hunt quit his positions at the Royal Society and University College London within days. Despite UCL's disavowals, the impression is that he was defenestrated without the benefit of due process: the right move, maybe, but made the wrong way.

Cathartic though this might be for those angry with him and with the slow advance of equality in science, it is not very productive. The majority of Hunt's supporters agree that science should be free of sexism. But berating and summarily dispatching every offender is neither practical nor compassionate. And, beyond sending a signal, it does little to address broader institutional, rather than individual, sexism.

"Cathartic though a resignation might be, it doesn't address broader institutional sexism"

A better response might start with self-reflection, and seek to address deep-rooted biases. The list of commitments suggested by physics professor Athene Donald at bit.ly/BiasPledge is a good place to start. It would be good if all of our scientific establishments paid more than lip service to them, too.

Because those biases certainly exist. In science, engineering and maths, many more men hold senior academic positions than women. You might speculate that this reflects innate differences in aptitude – as Harvard president Larry Summers notoriously did at a conference on diversity in 2005. But even if that difference existed

(and it doesn't seem to), a 2012 study revealed that science faculty members, given identical CVs, are more likely to consider male candidates to be qualified, hire them and pay them more.

This isn't just a matter of social justice. Unrecognised biases can skew science, too. Our ideas about sexual selection have long been dominated by the "shy, coy female" model popular with Victorian scientists; only now are we moving beyond it (page 34). Other areas of science may be similarly afflicted. To pick one pertinent example: psychologist Cordelia Fine argues that the idea of essential differences between male and female minds – as cited by Summers, who later quit – persists because of "neurosexism" (4 September 2010, page 42).

One reason science works is that it employs tools to identify, account for and neutralise bias. Double-blind trials make sure medicines work; statistical analysis ensures we know what is really happening. But observers have long noted that cultural imperatives also shape research. Any biases introduced are hard to tackle, but a scientist can be truly confident in a result only if they are tackled. Working out how to do that is surely not beyond the wit of the scientific community. ■



Greek resolution sought

Ivory evidence lost

IT'S crunch time. Over a tonne of confiscated ivory was crushed in New York's Times Square last week.

While such public destruction sends a powerful anti-poaching message, it also obliterates vital

"We were very surprised that over the past decade the ivory came from just two locations in Africa"

forensic evidence, says Sam Wasser of the University of Washington in Seattle. Because crushed items are mixed together, DNA cannot be used to match individual items to their source.

Wasser's team used ivory stockpiles to identify two major poaching hotspots. They first set up a map of all major elephant populations, based on 15,000 DNA samples collected from elephant dung across Africa. They then traced illegal ivory from 28 major seizures back to its site of origin by analysing its DNA.

Their analysis reveals that since 2006, almost all the seized ivory has come from just two places:

Tanzania – which has lost 60 per cent of its elephants over the past five years – and an area of western Africa spanning parts of Gabon, the Republic of the Congo and Cameroon (*Science*, doi.org/5h6).

"We were very surprised to find that the ivory came from just two locations in Africa," Wasser said. "It means we can target these areas for law enforcement."

The DNA information has already been useful in targeting poachers and smugglers, and to unravel trafficking networks, says William Clark of Interpol. "Every tusk should be sampled."

TOUIDE ROY/MINDEN PICTURES



Species need protection

Eurozone still in trouble

THIS is not a Grexit. The risk that Greece will default on its debts and exit the euro seems to have decreased. Greece has agreed to raise more government funds to make debt repayments due this month to the International Monetary Fund, in the hope of convincing the IMF and European Central Bank to continue financing its debts.

But experts on the complex physical dynamics of networks say the approach fails to deal with the real problem – the structure of the underlying network. Greece plans to raise taxes without the austerity measures that triggered humanitarian hardship and shrank GDP when the crisis broke in 2012. But Jordi Bascompte of the University of Zurich, Switzerland, says no one is discussing

how the eurozone network is structured. "Network dynamics cannot be reduced to the behaviour of single nodes," he says. "We have to think network-wide."

Networks with loose links between clusters of closely connected members and with a high level of equality seem most stable.

Bascompte's team has found that a network of countries can become unstable and members go "extinct" if their wealth is too unevenly distributed and competition outweighs cooperation (*Interface*, doi.org/5m4).

The eurozone has remedied some of its instabilities – for example, by collectively supporting member-governments' bonds. But a Grexit could still threaten the network.

Pluto preview

THE trailer will soon be on a screen near you. As *New Scientist* went to press, the NASA probe bound for Pluto was preparing to take its first infrared pictures of the dwarf planet, which will reveal details of what its surface is made of.

When New Horizons passes Pluto on 14 July, the visible light images will be the stars of the show. Even by the end of June, the craft should be close enough to take sharper pictures than any other camera has managed.

And, behind the scenes, its

infrared camera will pick up the signatures of molecules on the dwarf planet's surface, mapping frozen water, carbon monoxide and nitrogen – plus any organic compounds. The first infrared images probably won't show surface features, but they're a dry run for more in-depth studies in the coming months.

"Now is the right time to do it," says team member Will Grundy of Arizona's Lowell Observatory. An early dress rehearsal will give the team enough time to test the spacecraft's instruments and to practise analysing new data.

Age of extinctions

GOOD news or bad? The latest update to the IUCN Red List of Threatened Species shows that many species are in decline – but contains no additions to the extinct category.

Almost 23,000 of nearly 80,000 species that the IUCN has information on are threatened with extinction. In the update, 14 species have been moved into the critically endangered category.

The absence of more species in

the extinct category is largely because proving extinction is difficult, says Craig Hilton-Taylor, head of the IUCN's Red List Unit.

But evidence is growing that the world is entering another period of mass extinction. Gerardo Ceballos at the National Autonomous University of Mexico and his team found that vertebrate species have been lost at up to 114 times the normal rate during the past century (*Science Advances*, doi.org/5mm). Both Ceballos's team and the IUCN stress that averting a dramatic loss of biodiversity is still possible through conservation efforts.

Telescope to rise

GET out the shovels. After a two-month pause and potential abandonment, construction on Hawaii's Thirty Meter Telescope was set to resume on 24 June.

Work ground to a halt in April after native Hawaiians raised concerns and held protests, saying that the project disregarded their culture and local ecology.

When it is finished in the early 2020s, the TMT will be the largest of the 13 telescopes on Mauna Kea's 4200-metre peak. With nine times the collecting area of the current biggest, the TMT could capture the universe's first light.

However, plans to build the telescope, in addition to the existing dozen, were met with criticism and activism from native Hawaiians and others.

On 26 May, after talks, Hawaii's governor David Ige stated the TMT could move forward, provided that a quarter of the other telescopes shut before the 2020s and that much of the land be returned to the state by 2033.

Before work resumes, Ige said on 20 June, the TMT team will inspect the site and fence its perimeter. Those wishing to honour traditions related to the mountain will be allowed to enter. The group Sacred Mauna Kea Hui promised to continue blockades.

Weedy benefits

DON'T expect a medical miracle from marijuana. A review of 79 clinical trials has found little evidence that the drug is effective in treating conditions such as chronic pain and depression.

"Most trials reported greater improvement in symptoms with cannabinoids compared with control groups," says Penny Whiting of the University of Bristol, UK – but in many cases the results were not statistically significant (*JAMA*, DOI: 10.1001/jama.2015.6358).

Over the past 20 years,

Washington DC and 23 US states have introduced laws permitting the use of medical marijuana – but this doesn't mean it is an effective treatment.

The drug is not currently tested

"There is little evidence that marijuana is effective in treating chronic pain and depression"

through the US Food and Drug Administration, as all others are, which is akin to "putting the cart before the horse", say Deepak Cyril D'Souza and Mohini Ranganathan at Yale University.

Taylor shakes off Apple

BABY, now we've got bad blood. When mega pop star Taylor Swift complains, you'd better listen. This week, tech giant Apple bowed to Swift after she complained its upcoming streaming service was unfair on artists.

Earlier this month, Apple unveiled an app called Apple Music, an audio streaming service with a monthly subscription fee. It will be launched on the iPhone at the end of June, when it will compete with Spotify, Pandora and others.

It had already seen a backlash from indie labels, which complained that Apple wasn't going to pay artists or producers for the music played during three-month free trials for new users.

On Sunday, Swift joined the chorus of critics with an open letter online,

calling the decision "shocking" and saying she would withhold her latest album, *1989*, from Apple Music. "Three months is a long time to go unpaid, and it is unfair to ask anyone to work for nothing," she wrote.

Streaming services are already tough on artists. A single play on a popular app like Spotify or Pandora earns them only a fraction of a cent. Jay-Z's Tidal, meanwhile, charges higher prices for better-quality audio and claims to pay artists more.

Hours after Swift published her letter, Apple capitulated, announcing that it would pay artists during the free trial period after all.

"We hear you, [Taylor Swift]," tweeted Eddie Cue, a senior vice-president at Apple.

CHAD BATKA/NYTREDUX/EYEVINE



Swift knew Apple was trouble

Neanderthal grandma

A 40,000-year-old human jawbone found in a Romanian cave may have had a Neanderthal great-great-grandparent. Its DNA contained the strongest Neanderthal signature from any prehistoric or modern human ever tested (*Nature*, DOI: 10.1038/nature14558).

Third try for SpaceX

Private space firm SpaceX is gearing up for its third attempt to land a rocket on a platform in the Atlantic. In the first two tries, the rocket reached the barge it was aiming for, but exploded instead of landing softly. Success could mark the start of a new era of reusable spacecraft.

Cancer deaths

Family doctors could prevent an extra 5000 cancer deaths a year in England, according to the National Institute for Health and Care Excellence. Its new guidelines for identifying cancers earlier say GPs should focus more on symptoms and save time by ordering tests themselves rather than referring cases to specialists.

Rampant racehorses

They're romping ahead of their ancestors. Racehorses are faster than ever, says a study on more than 616,000 race times of some 70,000 horses between 1850 and 2012. Speeds of elite-race winners have increased by about 10 per cent for flat races across all distances (*Biology Letters*, DOI: 10.1098/rsbl.2015.0310).

Skinny-jeans scare

Don't squat in your skinnies! A 35-year-old woman was hospitalised for four days after hours squatting in skinny jeans while helping a relative move house. Doctors found evidence of nerve and muscle damage in her lower legs (*Journal of Neurology, Neurosurgery & Psychiatry*, DOI: 10.1136/jnnp-2015-310628), and her calves were so swollen that the jeans had to be cut off.

Don't fear apocalyptic asteroids

The risk of incoming space rocks is overblown. Here's why, says **Jacob Aron**

ON 30 JUNE 1908, an asteroid struck Earth, devastating an area the size of a large city. Luckily the Tunguska region of Russia where it landed was mainly forest.

On the anniversary of the Tunguska blast next Tuesday, a group led by astrophysicist and Queen guitarist Brian May and film-maker Grigorij Richters will host Asteroid Day, a celebrity-studded event in San Francisco and London designed to raise awareness of the potentially catastrophic risk of an impact.

So should we be concerned about apocalyptic asteroids? May and Richters think so. They and other supporters of Asteroid Day – including Chris Hadfield, Brian

"The popular conception of asteroids is that they are menacing and going to kill us all, and it's just not true"

Cox and Richard Dawkins – have signed a declaration calling for a 100-fold acceleration of efforts to detect near-Earth asteroids in the next decade and increased funding to achieve this goal.

"We're talking about things that might 'only' set the world economy back by a thousand years, or might 'only' kill 100 million people," says Ed Lu, chairman of the B612 Foundation in Mill Valley, California. Named after the asteroid in the children's classic story *The Little Prince*, B612 is a non-profit organisation aiming to build an asteroid-hunting space telescope.

There is no doubt that massive space rocks have the potential to harm life on Earth – just ask the dinosaurs. But asteroid-trackers say existing sky surveys already keep us safe, and events like Asteroid Day risk scaring people unnecessarily.



SAM FURLONG/SWNS.COM

The sky's not falling in just yet

In this section

- RNA world never existed, page 10
- Messy humans won't spoil Mars, page 14
- How to stop the ISIS propaganda machine, page 18

"The asteroid impact threat is very easy to overstate and misunderstand," says Eric Christensen of the University of Arizona in Tucson. "The popular conception of asteroids is that they are menacing and going to kill us all, and it's just not true."

Christensen heads the Catalina Sky Survey, a NASA-funded initiative tasked with identifying potentially hazardous asteroids using sensitive ground-based telescopes. In the past decade or so, Catalina, other ground-surveys and NASA's WISE space telescope have spotted thousands of near-Earth objects (NEOs).

As you would expect, larger asteroids are easier to spot, but there are fewer of them. Surveys show that we have found nearly all of the potentially world-destroying asteroids – those larger than a kilometre – but many smaller ones are uncatalogued.

Astronomers can estimate how many asteroids of a given size are out there, even if we haven't seen them all, by looking at the rate of re-detection, or how often we see the same asteroid a second time. If we consistently see the same set of kilometre-sized rocks, and no new ones, then we can be pretty sure we have found them all.

For rocks below that size, the gap between the number we have seen and the number we think are out there widens, according to a recent paper that lays out the known unknowns (*Icarus*, doi.org/5mn, see graph, above right).

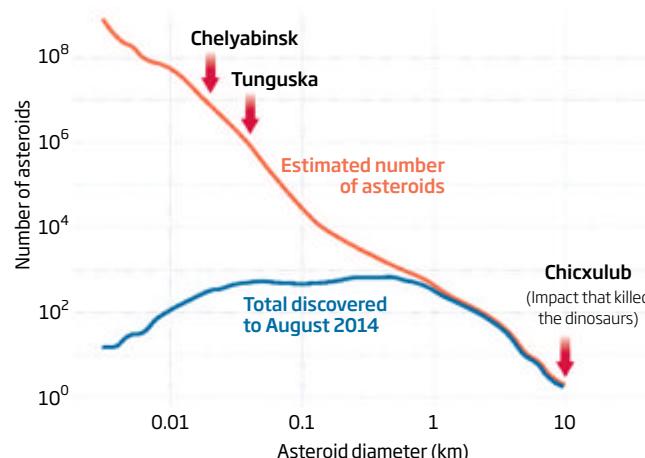
Asteroid Day supporters argue this gap in our knowledge puts us at risk of being blindsided by an unseen threat.

A meteor that exploded over Chelyabinsk, Russia, in 2013 illustrates the potential risk. Although the rock was only around 20 metres across, it was the most energetic explosion recorded since Tunguska. No one died, but about 1500 people were injured as the blast blew out windows and damaged buildings.

The event was alarming, especially because no one saw it

Big gap, small danger?

Astronomers can use previous asteroid observations to estimate how many rocks are out there. We have found nearly all the large ones, but there could be a lot of smaller asteroids we haven't found yet



coming. But astronomers still don't expect another any time soon. Chelyabinsk-sized rocks are expected to hit Earth every few decades, but because the vast majority of the planet is either ocean or uninhabited, the risk to humans is minimal.

"It's probably going to be centuries before an asteroid like that hits over a populated area," says Christensen. "If you go up to the size of a Tunguska impactor, the next one will likely hit us within a few centuries and impact over the ocean."

So if we are safe from the really big asteroids, and the smaller, more frequent ones are likely to hit without major incident, what's the problem? It all depends how much risk you're willing to accept, and how much money you are willing to spend to mitigate it.

Martin Rees of the University of Cambridge, who has signed the Asteroid Day declaration, says it's like calculating an insurance premium: you multiply the risk of impact by the cost of damage. By that measure, it is worth spending a billion dollars a year on reducing asteroid risk, he says.

That's 25 times as much as is allocated now. NASA currently spends around \$40 million annually on asteroid surveys

and related activities, and has instructions from US Congress to find all space rocks above 140 metres by 2020. In a report last year, NASA's Inspector General stated that the agency is unlikely to meet that without additional funding, so it is seeking a further \$10 million in 2016.

Linda Billings, a space policy researcher in Washington DC and consultant to NASA on NEOs, says this budget request is welcome,

It's the same as calculating an insurance premium: you multiply the risk of impact by the cost of damage"

while another \$200 million a year would fund a dedicated space-based survey telescope, or an asteroid deflection mission every few years.

Teaming up with other organisations could bring costs down. NASA is currently in the early phases of a test mission with the European Space Agency to smash a spacecraft into a harmless 800-metre asteroid in an attempt to deflect it. Dealing with larger bodies would likely require a nuclear explosion.

But Asteroid Day's proposed 100-fold acceleration is over the top, Billings argues. "My

colleagues in the observing community say this is not a reasonable goal," she says. "It has nothing to do with available funding, it has to do with the way that observers find and track asteroids: it takes time."

Christensen also questions this goal. "If the problem is trying to warn the people of planet Earth before every asteroid impact down to 3-metre sizes, I would ask why are you doing that?" he says. "Within the next few days the Earth will be hit by an asteroid that is maybe a few metres in size, and all it will do is provide a nice light show. The risk is so small that I'm not sure the enormous cost to efficiently detect all of those asteroids is worth it."

Rees is supportive of B612's Sentinel space telescope, which the foundation says will cost \$450 million to build, money it hopes to raise through private donations. Originally due for launch in 2017, the scope has now been pushed back to 2019, Lu says.

B612's tax filings show the organisation has some way to go to reach its funding target. In 2011, before it began seeking donations for the telescope, the Foundation raised \$90,000. That rose to \$1.6 million in 2013, the latest year for which filings have been published. Much of the 2013 funding went towards the salaries of Lu and Danica Remy, B612's chief operating officer, who received \$240,000 and \$204,279 respectively.

Leaving aside salaries, an asteroid-hunting space telescope may not even be the best use of funds, Christensen says. "You could accomplish a lot of the same task with a couple of 4-metre dedicated telescopes from the ground, and that would not be half a billion dollars."

Supporters say Asteroid Day will excite and engage young people. That's good, says Billings – but don't go to bed fearful that the sky will fall in. "I worry a lot more about my neighbour's hemlock tree falling on my roof." ■

RNA world may never have existed

Bob Holmes

WITHIN every living cell lurks a relic from the earliest stages of life on Earth, like a flint spear point in a modern military arsenal. Its discovery is overturning our understanding of how we came to be – and could signal the end of the favoured explanation of the origin of life, “RNA world”.

Life has a chicken-and-egg problem: enzymes are needed to make nucleic acids – the genetic material – but to build them you need the genetic information contained in nucleic acids. So most researchers assume that the earliest life, long before the evolution of cells, consisted of RNA molecules. These contain genetic information but can also fold into complex shapes, so could serve as enzymes to help make more RNA in their own image – enabling Darwinian evolution on a molecular level.

At some point, the idea goes, this RNA world ended when life outsourced enzymatic functions to proteins, which are more versatile. The key step in this

“This is the origin of life. The marriage between RNA and protein is the oldest part of biology”

switch was the evolution of the ribosome, a structure that builds protein molecules from genetic blueprints held in RNA.

But such a transition would require abandoning the enzymatic functions of RNA and re-inventing them in proteins. “That is not a simple model,” says Loren Williams, a biochemist at the Georgia Institute of Technology in Atlanta.

Williams has further reason to question the RNA world. His

detailed study of the ribosome shows that its most ancient part, which is identical in every living thing, acts as an enzyme to link amino acids in a growing protein chain. But this ribosomal core works pretty badly, Williams told the Astrobiology Science Conference in Chicago last week, and so is unlikely to be the product of a long period of evolution by natural selection.

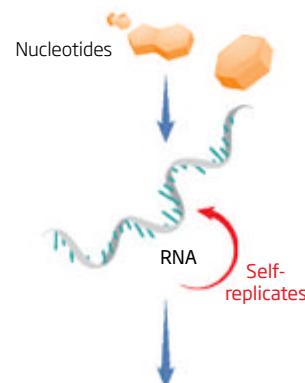
It has none of the precision of protein enzymes, which have precise three-dimensional shapes and positive and negative charges positioned just right for stabilising the intermediate stage of a specific chemical reaction.

The world that never was

It was thought that life originated solely with self-replicating RNA – the “RNA world”. But new evidence suggests RNA co-evolved with proteins from the very beginning

RNA world

RNA – the holder of genetic information – forms from nucleotides and catalyses its own replication



A crude ribosome evolves and turns RNA information into proteins, which then take over as life's enzymes



Instead, the ribosomal core is essentially a box in which any right-sized ingredients can be held and shaken until something happens, says Williams. Rather than natural selection, he thinks it results from more primitive chemical evolution, in which some compounds become more common, but there is no heredity so the next generation doesn't look like the one before, and the most successful solutions aren't necessarily the ones that survive.

How would this have worked? Nick Hud, also at Georgia Tech, has an idea. Modern proteins and RNA don't assemble on their own, but Hud has found relatives of each that do, spontaneously forming protein-like molecules up to 14 amino acids long as well as gene-like rows of proto-RNA, he reported at the same conference.

In Williams's scenario, these crude proto-proteins and proto-

RNA would have happened to form a ribosomal core, which helped accelerate the random assembly of more protein and RNA molecules (see diagram). “This is the origin of life. I think this came before replication,” says Williams.

Ancient biology

Any particular proteins or RNA molecules that happened to stabilise one another would accumulate, making the molecular mix increasingly predictable over time. At some point, the proto-RNA and proto-proteins could have started cooperating as crude enzymes to help replicate the RNA sequence, sparking the transition to true Darwinian evolution.

If Williams is right, RNA has cooperated with proteins from the very beginning. “This marriage between RNA and protein is the most ancient and fundamental part of biology,” he says. If so, those who are trying to build self-replicating RNA molecules in the lab are looking for something that never existed.

Not everyone agrees with this idea, however. “There are other reasons to expect a complex RNA world,” says Steven Benner at the Foundation for Applied Molecular Evolution in Florida. Many modern protein enzymes, for example, have RNA associated with them that serves no functional role. This implies that they must be relics from a time when RNA was the only thing around, he says.

Williams is now synthesising what he thinks is the most ancient ribosomal core, free of all its later add-ons, to test whether it really assembles RNA and protein molecules.

The testability that Williams and Hud bring to these questions is what sets their work apart, says Anthony Poole of the University of Canterbury, New Zealand. “We might have thought about it, but we didn't have a way to test it. Now they've done that,” he says. ■

HOW ONE CELL BECAME MANY

Hurdle cleared. It seems that the leap in evolution needed to switch from single-celled to multicellular life wasn't the giant evolutionary challenge we thought - and could have happened in a number of ways.

At some point after life emerged, perhaps as early as 2.1 billion years ago, some cells came together to form a multicellular organism - the first step to complex life, such as humans.

To investigate how this came about, in 2011 William Ratcliff and Michael Travisano at the University of Minnesota in St Paul coaxed unicellular yeast to take on a multicellular "snowflake" form (see photo) by repeatedly taking the fastest-settling yeast out of a culture and using it to found new cultures.

As clumps settle faster than individual cells, this effectively selected yeast that stuck together

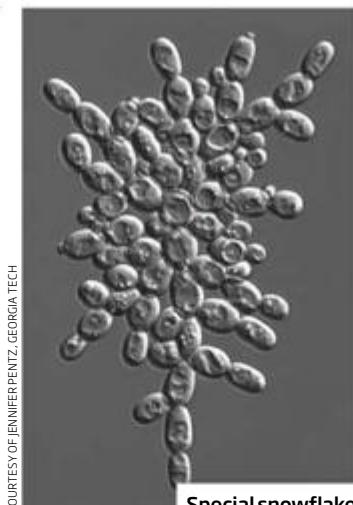
instead of separating after cell division.

Ratcliff has now found that the switch to clumping behaviour can be driven by a single gene, called *ACE2*, that controls separation of the cells produced by cell division. He presented the work at the Astrobiology Science Conference in Chicago last week.

This also allows the snowflakes to evolve as what is effectively a multicellular organism. As the snowflake grows in a branching pattern, any later mutations are confined to cells on single branches.

When the original snowflake gets too large and breaks up, these mutant branches fend for themselves, allowing the value of their mutations to be tested independently.

"A single mutation creates groups that as a side effect are capable of



COURTESY OF JENNIFER PENTZ, GEORGIA TECH

Special snowflake

Darwinian evolution at the multicellular level," says Ratcliff, who is now at the Georgia Institute of Technology in Atlanta.

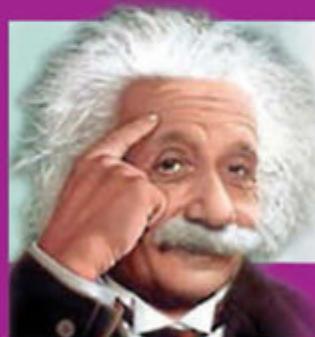
Meanwhile, a team led by Matt Herron of the University of Montana showed that selection for clumping

can be driven by predators. The team exposed single-celled *Chlamydomonas* algae to a protozoan that can devour single-celled algae but not multicellular ones.

Algae in two of Herron's five experiments became multicellular within six months, or about 600 generations, he told the conference. They also had the rounded shape of naturally multicellular algae, rather than the amorphous blobs seen in previous algae experiments with selection for settling.

"It's likely that what we've seen in the predation experiments recapitulates some of the early steps of evolution," he says.

But neither experiment has shown single cells cross the critical threshold to multicellularity: division of labour. "They're opening up new avenues for approaching this question," says Richard Michod of the University of Arizona in Tucson. Bob Holmes ■



“Fifty years of pondering have not brought me any closer to answering the question, what are light quanta?”

-Albert Einstein, 1951

For all who want to understand physics, the answer is here!

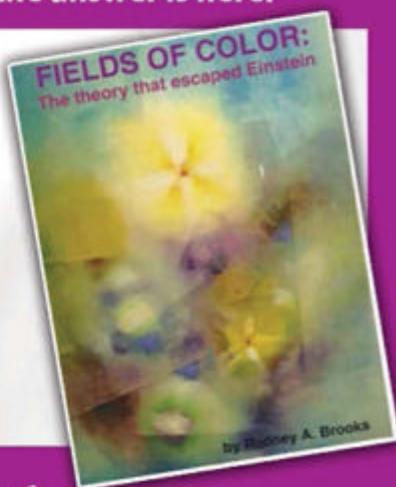
“Fields of Color” explains quantum field theory to a lay audience without equations. It shows how this often overlooked theory resolves the weirdness of quantum mechanics and the paradoxes of relativity. And yes, it explains what light quanta are.

From reviews at amazon.com:

“Wonderful book”

“Opened my eyes”

“Finally it all makes sense”



To buy or look inside visit: www.quantum-fields-theory.net



Life-saving subway

Take climate action to improve health

Andy Coghlan

DRIVING a car and eating red meat are not only bad for the climate – your health suffers too. All the more reason to curb our carbon habit, says a report by the Climate Health Commission.

This panel of health researchers was appointed by *The Lancet* journal to assess the potential health benefits of tackling climate change, as well as the likely consequences of failing to do so.

The panel's report, published on 23 June, cites huge health advantages as a reason for switching from fossil fuels to renewable energy sources such as solar and wind power.

It says doubling the proportion of renewable energy from its 2010 level of 18 per cent to 36 per cent could save \$230 billion in healthcare costs worldwide annually by 2030 – a saving of about 3 per cent.

This is because a large amount of ill health is directly or indirectly caused by burning coal, oil and gas. According to the World Health Organization, air pollution

kills an estimated 7 million people every year, while 88 per cent of the world's population breathes air that falls short of its quality guidelines.

This has led to an epidemic of heart and respiratory disease. Switching to public transport, or cycling or walking to work, would boost health through lowering pollution and increasing physical exercise. Similarly, eating fewer fatty foods and less red meat, whose production contributes to climate change by generating

All the things we want to do to combat climate change will also protect us against ill health"

methane gas, could help reverse obesity and some cancers. "There are many win-win situations here," says Georgina Mace of University College London, a member of the commission.

The report cites research suggesting that adopting strategies to bring carbon dioxide emissions below current levels by 2070 would soon start saving

lives. This particular carbon-cutting scenario is known as RCP 4.5, and achieving this would mean the world is likely to experience an average rise in temperature of more than 1.5 °C. However, it could also prevent 500,000 premature deaths a year by 2030, rising to 2.2 million by the end of the century.

"All the things we want to do to combat climate change will also protect us against ill health," said Anthony Costello, also of UCL, and co-chair of the commission.

"We want to shift the balance from talk of catastrophes to a 'we-can-fix-this' mentality," he added at the launch of the commission's report.

The commission is calling on governments to collectively inject an extra \$1 trillion into developing and encouraging the uptake of renewable technologies, as well as preparing cities and citizens for measures that blunt the impact of global warming. It's a large sum, but much smaller than the \$5.3 trillion in subsidies that the International Monetary Fund projects the fossil fuel industry will receive in 2015.

"The usual excuse for not investing in renewables is that it's too expensive, but we think it represents prudent future expenditure," says Paul Ekins of UCL, the team's economist. ■

Lava lakes may be how Venus stays youthful

VENUS is leaking lava. Researchers have found oozing volcanoes on our closest planetary neighbour, a discovery that may help solve the planet's deepest geological riddle.

Past observations revealed that Venus's surface is "new", at least in geological terms. Because it doesn't sport many craters, scientists think the planet has been paved over by upwelling lava within the last billion years. There have been hints of more recent volcanism, too, but no solid evidence of fresh lava.

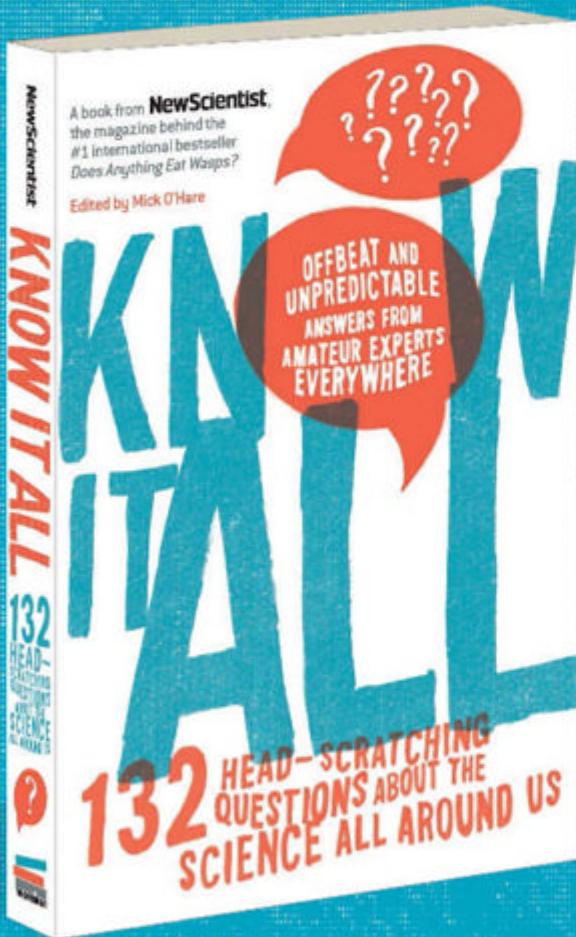
Until now, Eugene Shalygin of the Max Planck Institute for Solar System Research in Göttingen, Germany, and his colleagues have dug through data from the European Space Agency's Venus Express probe, which orbited from 2006 until 2014. They found short-lived hot patches they attribute to lava lakes bubbling up along a rift.

The team was interested in thermal imaging at wavelengths that penetrate the thick Venusian clouds and looked only at the clearest images available. They found blobs that grew hotter over a few days and then quickly cooled – as expected for lava flows quenched under the pressure of the atmosphere (*Geophysical Research Letters*, doi.org/5kj).

"This is such beautiful evidence for volcanism," says Lindy Elkins-Tanton at Arizona State University in Tempe. Previously, it wasn't clear whether Venus spewed lava in frequent trickles or catastrophic global floods. The findings suggest that some flows are little and often.

Active volcanoes also mean the planet has a "tiny little carbon cycle", Elkins-Tanton says, which churns between its atmosphere and its insides. We think the exchange of carbon is important for planets to maintain a balanced climate. While Venus's cycle clearly wasn't enough to make it habitable, the fact it's there at all may imply that exoplanets like it, with just one tectonic plate, can keep stable atmospheres. Joshua Sokol ■

THE BAFFLING, TRIVIAL, CURIOUS, OR STRANGE . . . KNOW IT ALL



“The experts at *New Scientist* magazine have published a book that answers some of the oddest but most entertaining questions they’ve been asked.”

—DAILY MAIL

NewScientist



@experimentbooks
theexperimentpublishing.com

The latest book in *New Scientist* magazine’s bestselling “Last Word” series presents 132 science questions and answers from amateur experts and curious minds everywhere. Find the answers to the **microscopic** (*Why do sand particles on a beach seem to reach a certain grain size and then reduce no further?*), the **puzzling** (*How did the Romans express fractions?*), the **hypothetical** (*If humans lived in a zero gravity space station away from the sun, would skin still wrinkle and sag?*), and the **practical** (*What’s the best strategy for getting through multi-lane traffic jams as quickly as possible?*)—any topic is fair game!

KNOW IT ALL: 132 Head-Scratching Questions About the Science All Around Us
\$14.95 • Available in trade paperback and as an ebook wherever books are sold

A GUARDIAN TOP 10 SCIENCE AND TECHNOLOGY BOOK

“Explain[s] some of life’s great mysteries.”

—REVEAL

ALSO AVAILABLE
Nothing: Surprising Insights Everywhere from Zero to Oblivion
\$14.95 • Available in trade paperback and as an ebook wherever books are sold



Messy humans won't spoil Mars

Jacob Aron

LANDING humans on Mars won't wreck the search for life on the Red Planet. That's according to researchers who simulated the impact of a crewed mission to a pristine world by driving across the Canadian Arctic.

Space agencies currently take great care to sterilise spacecraft bound for Mars, to avoid contaminating the planet with Earth microbes that could make it harder to find native Martian life.

But humans are impossible to

"Humans are impossible to sterilise, so when we go to Mars the contamination risk should be high"

sterilise. We are crawling with microbes, inside and out, so when we eventually go to Mars, the risk of contamination will be high.

Or at least, that's what we had assumed. To find out, Andrew Schuerger of the University of Florida in Gainesville and Pascal Lee of the SETI Institute in Mountain View, California, took advantage of an Arctic road trip.

During a series of trips between April 2009 and July 2011, Lee was part of a team driving a

specialised vehicle from mainland Canada to the inhospitable Devon Island, the site of a simulated Mars mission.

Although the main purpose of the trip was to deliver the vehicle to Devon Island, the team also took the opportunity to simulate the activities of a crewed rover on another planet, with the pristine snow and sea ice they drove over standing in for Mars.

During a week-long drive in April 2009 between Kugluktuk and Cambridge Bay, the team made three stops. At each, they took samples from inside the vehicle as well as the surface snow 10 metres away, to see the extent of their microbial footprint.

"We had a wonderful opportunity to sample the snow and try to get some measure of how far microorganisms were being dispersed," says Schuerger.

The samples were frozen, then later melted and cultured in the lab to look for bacteria and fungi. It turned out that 85 different microorganisms were found inside the rover, but only one bacterium and one fungus grew in samples from the snow outside (*Astrobiology*, doi.org/5h5).

The pair also found that levels of microbes in the rover declined



Make yourself at home

over time, suggesting the threat of contamination will fall as crewed missions progress. The intense UV radiation on Mars should help to keep things contained, says Schuerger: the vast majority of microbes will be killed after around 15 minutes of exposure. Even fossilised microbes won't last long enough to be a concern, new research suggests (see "Ancient aliens? Not so fast", below).

"These results are a huge surprise," says Alberto Fairén of

Cornell University in Ithaca, New York. "The theory says that the moment a human sets a foot on Mars, every effort to prevent contamination of the planet would go out the window."

Fairén has previously argued that space agencies are being too cautious when it comes to Mars – sterilisation and other planetary protection for the Viking Mars landers in the 1970s cost \$100 million. "A serious rethinking of where time and money are allocated in planetary exploration is clearly in order," he says.

NASA's planetary protection officer Catharine Conley points out that the methods the pair used wouldn't necessarily catch all microbes, so contamination could be worse than they measured. The search for life on the Red Planet is so important that extreme caution is a must if we want to find a true Martian microbe, she says. "The more contamination you have, the less easy it is to figure out whether [a Martian microbe] is real." ■

ANCIENT ALIENS? NOT SO FAST

If humans on Mars do shed organic molecules, they won't be mistaken for traces of extinct Martian life. The harsh radiation on the Red Planet's surface means that unless alien life went extinct fairly recently, we will have to dig deep to find traces of it.

Previously, we thought cosmic rays might take a billion years to destroy biomolecules. But those estimates assumed cosmic rays only did damage by striking them directly. Rays that

strike silicate grains or water in the soil can generate free oxygen radicals that also degrade organic molecules, says Alexander Pavlov of NASA's Goddard Space Flight Center in Greenbelt, Maryland.

To see how much damage they do, Pavlov bombarded a mix of amino acids and hydrated silicates with high energy gamma rays in the lab. After a dose equal to about 10 million years of Martian radiation, almost all the

amino acids had broken down, he reported last week at the Astrobiology Science Conference in Chicago, Illinois.

That's good news for astronauts, bad news for alien hunters. To see intact biomolecules, we'd need to find rocks exposed just a few million years ago, or drill at least 2 metres below the planet's surface – a depth only the ExoMars rover, to launch in 2018, could manage. Bob Holmes



TOMORROW'S MEDICINE TODAY

Discover the cutting edge of medical innovation and the unexpected places it takes us in *Medical Frontiers*

Buy your copy now from all good newsagents or digitally. Find out more at newscientist.com/TheCollection

NewScientist



Vanishing fish distorts its edges to blend in and hide

NOW you see it, now you don't. The slender filefish has a neat way to stay off the seafood menu - it has evolved the ability to become almost invisible.

Justine Allen of Brown University in Providence, Rhode Island, was amazed by how fast the fish camouflaged themselves when she saw them in the Caribbean. It took them just 2 seconds to match the colours of the sea fans, or gorgonians, they swam past. "It was just incredible watching the animal go from one gorgonian to the next and really quickly change its pattern," she says.

How does it work? To see an object for what it is, you

need to be able to perceive its edges, which mark it out as being separate from the background. Allen found that the filefish changes its coloration to create "false edges". For example, it can make a dark, longitudinal stripe appear on its body that looks like a real edge (*Biological Journal of the Linnean Society*, doi.org/5h7). The eye sees this false edge, and so can miss the true outline of the fish.

The fish also has small, protruding skin flaps that make its physical edges look less smooth or "fishlike". The flaps resemble structures such as coral polyps, small clumps of sand or bits of algae. This is enough to confuse predators and even practised researchers. "These animals have tricked my visual system more than once," Allen says. "The slender filefish's fast, adaptive camouflage behaviour is remarkable."

Superfast laser test for malaria

IT'S a weapon that fights malaria. A laser scan can give an accurate diagnosis in seconds, without breaking the skin, just like the fictional tricorder in *Star Trek*.

It works by pulsing energy into a vein in a person's wrist or earlobe. The laser's wavelength doesn't harm human tissue, but is absorbed by hemozoin - waste crystals produced by the malaria parasite *Plasmodium falciparum*

when it feeds on blood.

When the crystals absorb this energy, they warm the surrounding blood plasma, making it bubble. An oscilloscope placed on the skin alongside the laser senses these nanoscale bubbles when they start popping, detecting malaria infections in only 20 seconds.

"It's the first true non-invasive diagnostic," says Dmitri Lapotko

of Rice University in Houston, Texas, who used the probe to correctly identify which person had malaria in a test of six individuals (*Emerging Infectious Diseases*, doi.org/5hr).

The probe will soon be trialled in Gambia, and could cut the cost of a malaria test to less than 8 cents per person. Existing tests can cost as much as 50 cents and, because they require blood to be taken, can only be done by people with specialist medical training.

Early test found for pancreatic cancer

IT'S the sneakiest of cancers - and as many as 80 per cent of cases are identified too late. But we now have a way to test for pancreatic cancer before it spreads.

Researchers have identified a protein that is present in the blood at much higher levels when a person has the disease. Glypican-1 sticks out from the surface of exosomes, little globules that are thought to have budded off from pancreatic cancer cells.

Raghu Kalluri of the University of Texas MD Anderson Cancer Center in Houston found that there is so much more glypican-1 in people with pancreatic cancer that a blood test can be used to identify them (*Nature*, DOI: 10.1038/nature14581).

Kalluri says he hopes a test can be made available soon. One use for it would be to screen those at risk, such as obese over-60s who smoke and have a family history of the disease.

How the sun stole a frozen mini-planet

THE sun is a thief. More than 4 billion years ago, it stole hundreds of frozen mini-planets from a passing star - and the planetoid Sedna is one of them.

Sedna's extremely elongated orbit has been a mystery ever since its discovery in our solar system in 2003. One idea was that it and a dozen similar objects were jolted out of place by a passing star.

Now Lucie Jílková of Leiden Observatory in the Netherlands and her colleagues have simulated over 10,000 possible encounters between the sun and such a star. They conclude that the passing star was not a trouble-maker, but a victim: Sedna and its siblings were actually stolen from it when it ventured too close to the sun (arxiv.org/abs/1506.03105).

DNA cracks case of Kennewick Man

ALL it needed was a helping hand. The origins of the Kennewick Man may have finally been solved, through DNA evidence from a hand bone.

The controversial 8500-year-old skeleton was discovered in Washington state in 1996 and quickly became the subject of a legal battle between scientists who wanted to study it, and the Native Americans who wanted to rebury it under a repatriation act. Evidence based on his skull shape suggested the man was closely related to native Polynesians, not Americans. In 2004, the courts ruled that the Native Americans could not prove Kennewick Man was their ancestor, so repatriation laws did not apply.

But the new DNA evidence suggests he is indeed closely related to some Native Americans - and could even be their direct ancestor.

Eske Willerslev at the University of Copenhagen, Denmark, and his colleagues extracted and sequenced DNA from the man's hand bone and compared it with modern genomes. They found it resembled DNA from genomes of Native Americans from the Confederated Tribes of the Colville Reservation in Washington state more closely than any other genome in the world (*Nature*, doi.org/5jb). It's unclear whether the results will affect what happens to the remains now, Willerslev says.



How to home in on patient zero during disease outbreaks

WE'RE zeroing in. In a disease outbreak, "patient zero" is the first person to be infected, and finding them can help stop the outbreak. But incomplete information means that person is usually hard to track down. Now an algorithm could help.

Mile Šikic of the University of Zagreb, Croatia, and his colleagues focused on a scenario in which there is a network of infected and uninfected people, but you don't know when or who the infection passed between. This could be sexually transmitted infections

(STIs), the spread of information on a social network, or computer viruses that lie dormant before activating.

The team's algorithm simulates potential spreads through the network and compares them with real data, to calculate the probability that a particular person is patient zero. If just one person has a probability of 100 per cent, you have found the origin. But if multiple people have a score then you need more data to find patient zero (*Physical Review Letters*, doi.org/5h4).

It turns out that the origin is easier to find if the infection spreads quickly. "With a slower process, you lose some kind of information," Šikic says.

The team tested the method on STI data from a Brazilian website in which people anonymously review encounters with sex workers. They found that 60 per cent of the time the algorithm either correctly identified patient zero, or was one hop away. "If we cannot say who is patient zero, we can be in their neighbourhood," says Šikic.

Sharp decline in IVF success in late 30s

IVF can only stall natural declines in fertility for so long. Less than a quarter of women aged 38 are likely to have children following a course of IVF, while it works in just 1.3 per cent of women aged 44 or older.

"Age is the single most important factor in IVF success," says Marta Devesa of the Hospital Universitario Quiron-Dexeus in Barcelona, Spain. She presented the results from a study of more than 4000 women over the age of 38 at the European Society of Human Reproduction and Embryology annual meeting in Lisbon, Portugal, last week.

Her team found a sharp decline in the likelihood of a baby being born following a course of IVF after the age of 38. While women aged 38 and 39 had a 23 per cent chance of giving birth, this dropped to 6 per cent at 42 and 43. For women aged 44 or older, the success rate for those using their own eggs was 1.3 per cent.

"We know that the success of IVF sharply declines over the age of 38, but these women make up an increasing proportion of IVF patients," says Devesa. Women over 37 made up a third of those undergoing IVF in the UK in 2011.



NORMAN NAN SHI AND NANFANG YU, COLUMBIA ENGINEERING

Hairy back keeps Saharan ants cool

IT'S fashion front line, not fashion faux pas. During the hottest part of the day, when sand temperatures reach 70 °C, the hairy back of the Saharan silver ant repels the sun's rays and sheds excess heat.

Nanfang Yu from Columbia University in New York was intrigued by how each ant looked like "a droplet of mercury", so took a closer look.

Yu's team found that the ants' silvery appearance comes from a dense array of Toblerone-shaped hairs, which reflect visible and near-infrared light. The hairs are about the same thickness as the

wavelength of the sun's warming rays, so the rays bounce off their triangular walls.

The hairs are much thinner than the wavelengths of mid-infrared light so they allow those wavelengths of light to radiate away from the ants - effectively cooling them down. Ants with hair had body temperatures between 5 and 10 °C lower than those that had been shaved (*Science*, doi.org/5jc).

Their silvery coats allow the ants to scavenge the corpses of less-fortunate insects and arthropods under the midday sun.

Anti-recruitment drive

To stop foreign fighters joining radical groups like ISIS, crime-analytics software is being used to track people being targeted for enlistment

Chris Baraniuk

BRITAIN'S youngest suicide bomber. That is how the name Talha Asmal was introduced to the public last week. It is believed that Asmal, 17, blew himself up as part of a bombing linked to Islamic State (ISIS) at an Iraqi oil refinery. The attack killed 11 people. Now, in an effort to stop recruitment of people like him by radical groups such as ISIS, crime-analytics software is being used

"Radicalisation can be a fast process. Picking up and flagging the warning signs to police is the key"

to track those being targeted.

Asmal was from Dewsbury, West Yorkshire, and had travelled from the UK to Syria in March to join ISIS. The tally of young people recruited by the terrorist organisation from across western Europe and the US is growing.

More than 20,000 foreign fighters have joined the cause, surpassing the Afghanistan conflict of the 1980s (see "Joined-up thinking", below right).

The race is now on to stop people, especially the young, leaving their families to join the jihadi group. Looking at activity online has been suggested as a means of spotting those intending to leave.

One firm that has developed a way to do this is Wynyard, which makes software for law enforcement and intelligence agencies around the world. It claims its Advanced Crime Analytics software can spot foreign fighters before they join.

Wynyard demonstrated the software at an event in London earlier this month. It is designed to expose and disrupt connections between foreign fighters, recruiters and those they are targeting, says the company.

It sifts through millions of

online, open-source records such as Twitter accounts, blog posts and shared content, and investigators can include data recovered from legally obtained email accounts, phones and computers.

Phrases and names are analysed by an algorithm that processes natural language and generates a graphical representation of a network of suspected radicalisers and targets. The software looks for linguistic patterns and similarities tied to known instances of extremist material.

User accounts associated with or sharing extremist material are prioritised. If information is publicly tagged with a location, analysts can work out whether any individuals involved in sharing or discussing such material are in Syria or elsewhere.

Intelligence officers are subsequently able to zoom in on any node in the network to examine persons of interest more closely.



"If you have a particular terrorist or user that has actually radicalised people, you can update the police on a previous set of activities," says Mike O'Keeffe, product director at Wynyard.

Wynyard says it is not able to reveal which organisations are using its software, and a raft of agencies, including GCHQ, MI5 and the FBI declined to comment. Adam French, a spokesman for London's Metropolitan Police Service, says that a range of technologies are being used by police to help them investigate networks of radicalisation.

In the past 12 months, there have been 157 arrests in the UK related to Syrian travel plans. French says police may also use community liaison officers, who work closely with local communities, to intervene. "The process of radicalisation can be extremely quick and it's getting those warning signs picked up and flagged to police – that's the key part of it," he says.

THE ONLINE BATTLE FOR MINDS

"I wanted young people to stay away from terrorism," says UK comedian Humza Arshad in an online video. He discusses his work with police and explains the dangers of young people becoming seduced by extremist material.

It's far from the only video intended to counteract information emanating from militant group ISIS. In January, the French government launched one. And in Iran, a cartoon competition was held to undermine ISIS and challenge the group's glorification of executions, suicide bombings and the destruction of historic artefacts.

The UK Quilliam Foundation think tank has recommended the use of counter-narratives to dispel the allure of extremist groups and make individuals think twice about getting involved with them.

In the UK, the Muslim Youth League has been vocal in its condemnation of terrorist factions, which it says are ideologically incompatible with Islam. The league has used YouTube, Facebook and its own website to declare "a jihad against ISIS".

And the US state department has run a series of campaigns on Facebook and other social media

called "Think Again Turn Away", which uses graphic images taken from ISIS's own videos to deter would-be jihadists.

The battle is far from won, however. A study published by the Brookings Institution in Washington DC says there could be as many as 90,000 Twitter accounts worldwide supporting ISIS. The study doesn't recommend suspending such Twitter accounts, because that could end up isolating ISIS supporters online. "This could increase the speed and intensity of radicalization for those who do manage to enter the network," the report says.



Talha Asmal, right, salutes

JOINED-UP THINKING

Some 20,730 people from around the world have left their homes to join ISIS and other similar groups in the Middle East. The number of foreign fighters involved in the conflict in Syria and Iraq has now topped the number in the Afghanistan conflict of the 1980s.

Up to 11,000 of the fighters are from nearby countries, particularly Saudi Arabia and Tunisia. An estimated 3000 are believed to come from the former Soviet Union. The number from western Europe (shown below) almost doubled last year to about 4000, according to the International Centre for the Study of Radicalisation and Political Violence. Some 500-600 are from the UK, and some countries supply a disproportionate number given their populations.

| COUNTRY | ESTIMATED NUMBER OF FIGHTERS IN 2014 | NUMBER PER MILLION POPULATION |
|----------------|--------------------------------------|-------------------------------|
| Belgium | 440 | 40 |
| Denmark | 100-150 | 27 |
| Sweden | 150-180 | 19 |
| France | 1200 | 18 |
| Austria | 100-150 | 17 |
| Netherlands | 200-250 | 14.5 |
| Finland | 50-70 | 13 |
| Norway | 60 | 12 |
| United Kingdom | 500-600 | 9.5 |
| Germany | 500-600 | 7.5 |
| Ireland | 30 | 7 |
| Switzerland | 40 | 5 |
| Spain | 50-100 | 2 |
| Italy | 80 | 1.5 |

Software may be able to speed up such interventions, but it is not a perfect solution, says Jonathan Russell, political liaison officer at the Quilliam Foundation counterterrorism think tank. "It doesn't challenge why people want to go. So while I am supportive of these things," he

"There's one particular jihadist that we follow on Twitter who is on his 140th Twitter account"

says, "I'm quick to caution that we don't drop other, counter-narrative based strategies." (See "The online battle for minds", left.)

Another approach being used to tackle radicalisation is the removal of web content that promotes ISIS's message. From 1 July, a dedicated police unit run by Europol will start hunting down the accounts that put out ISIS propaganda. The UK Home Office states that more than 90,000 pieces of terrorist-related material have been scrubbed off the web since 2011, but Russell doesn't think this will work. "There's one particular jihadist that we follow on Twitter who is on his 140th Twitter account," he says. "It seems that when these negative measures are taken, [the website or radicaliser] just pops up in another form."

Radicalisation rarely happens solely through online channels, says Raffaello Pantucci of the UK's Royal United Services Institute think tank, but those channels can reveal changes in behaviour.

"There are a lot of radicalised people fighting in Syria and Iraq who are on the internet quite a bit – Facebook, social media, other sites. Collecting all their data and analysing it is a very big challenge," he says, and that information isn't always accurate or representative.

"A lot of people are online just saying stuff with no real-world intention behind it – how do you separate those out from the ones who are genuine?" he says. "That problem remains." ■

ONE PER CENT



Google's Inception

Welcome to the world imagined by artificial intelligence. The surreal image above started as a photo of random noise that Google ran through one of its image-recognition neural networks. The program looked for objects, then enhanced the patterns it found and repeated the process. This led to weird, psychedelic images (view more at bit.ly/googleinception).

"This won't solve the problem of revenge porn but we hope that honouring people's requests... can help."

Google says on its blog that it will remove sexually explicit images from its search results if notified that the material was shared without the person's consent

Don't say cheese

Facebook can recognise people in photos even without seeing their faces. Instead it looks for unique clues like hairdo, clothing, body shape and pose. Yann LeCun and his team used almost 40,000 public photos from Flickr and ran them through a neural network. It recognised people with an accuracy of 83 per cent. Photo apps could use the system to spot friends and family automatically.

INSIGHT Privacy

MARK LIDDELL/REDUX/EYEWITNESS



Not just a face in the crowd

Know that face anywhere

Firms want to identify you in the street – without your permission

Hal Hodson

IF YOU are walking down the street, a public street, should a company be able to identify you without your permission?

That was the key question that caused talks about face recognition technology among privacy advocates, the US government and consumer groups to fall apart quite spectacularly earlier this week.

The talks were meant to develop a code of conduct for the use of this technology – which is becoming increasingly pervasive – but collapsed after the privacy advocates stormed out in protest.

Alvaro Bedoya of the Georgetown University Law Centre in Washington DC says this happened in the face of inflexibility from industry players when trying to agree on correct conduct in the simple, hypothetical case above.

Bedoya and other privacy advocates thought the answer

was obviously no, but the tech companies disagreed. "We asked if we can agree on this edge case, but not a single company would support it," he says.

The lack of a current consensus means face recognition is moving into creepy territory. One example is California-based company Face First, which is rolling out a system for retailers that it says will "boost sales by recognising high-value customers each time they shop" and send "alerts when known litigious individuals enter any of your locations".

"What facial recognition allows is a world without anonymity," says Bedoya. "You walk into a car dealership and the salesman knows your name and how much you make. That's not a world I want to live in."

Another company, called Churchix, is marketing facial recognition systems for churches. Once pictures of the church's members have been added to a

database, the system tracks their attendance automatically. It also claims to be able to discern demographic data about the congregation, including age and gender.

"Companies are already marketing products that will let a stranger point a camera at you and identify you by name and by your dating profile," says Bedoya. "I think most reasonable people would find this appalling."

Online technology companies that use facial recognition have

"You go into a car dealership and the salesman already knows your name and how much you make"

had to set their own policies for it. Google and Microsoft are known for having the best policies, requiring users to explicitly opt-in. In Microsoft's case, your facial profile never leaves your device, for example, your Xbox.

"Microsoft takes an opt-in

approach to facial recognition and we would encourage other companies to do the same," a spokesperson for the company said. "We believe the stakeholder process is important and that is why we are participating. Should there be a consensus that an opt-in approach be adopted, that is something that we could support."

But no such consensus was reached.

While negotiating rules for face recognition has failed for now, Ben Sobel, also of Georgetown, points out that the US states of Illinois and Texas – which together make up an eighth of the country's population – already have privacy laws that govern the collection and processing of biometric data.

Facebook is being sued in Illinois, where it is alleged that the social network's face recognition system violates the state's laws.

But why don't technology companies take threats like these seriously? Jennifer Lynch of the Electronic Frontier Foundation, a privacy advocacy group based in San Francisco, says it's because doing so would constrain what they can do with the technology in future.

"We've seen this from the birth of commerce on the internet – companies collect as much data as they possibly can on people, because of the possibility that it might be useful," says Lynch. "We discourage companies from doing that because it means all of that data is available for the government to come asking."

"This is just the beginning of a very important conversation," says Kate Crawford of Microsoft Research. "Facial recognition is one of many remote biometric sensing technologies. There's also gait detection, iris scanning, heartbeat recognition and many others. We need a deeper discussion of the social and ethical implications of these capacities as well as who gets to use them, where and how." ■

Get your resumé to the top of the pile

Register your resumé on New Scientist Jobs
to ensure the best employers can find you!

- ★ Be headhunted by relevant recruiters in science, research and academia
- ★ Apply for jobs quickly and easily with your saved resumé

UPLOAD CV >>



Upload your CV today at:
NewScientistJobs.com







Yellow flash

NORTHERN flicker sounds like something that might go wrong with your TV set in Manchester. In fact it is this spectacular North American woodpecker.

If you spotted one on a tree, you'd see a handsome bird with brown and black plumage. It's only when they take to the air that they flash their unmistakable colours. The bird pictured here, and below, erupting from its nest in Alaska is the yellow-shafted form of the species (*Colaptes auratus*), found across the east and north of the US and Canada. In the west you would see a red-shafted flicker.

But if you meet one up close and are still unsure what bird you are looking at, wait until it sticks out its tongue. It is thought to be the longest of any bird in North America, up to 12 centimetres in length. Woodpeckers' tongues are attached differently to other birds, curling up behind the skulls - which are themselves specialised to withstand the intense mechanical shocks caused when the birds drum against a tree trunk.

An urban legend claims that the flicker can use its monster tongue to catch bats as they leave their roost - but given that it mostly forages on the ground for ants and beetles, we don't believe a word of it. Marie Deschamps



Photographer

Michael Quinton
Minden Pictures

Papa do preach

The pope is a vital moral ally in science's fight for climate action, say **Veerabhadran Ramanathan, Partha Dasgupta** and **Peter Raven**

IT IS probably not too late to contain the warming of our planet and the climate chaos that would ensue – scientific and technological solutions exist for us to do that. But people and institutions rarely change their behaviour when they believe that they stand to gain more, at least economically and politically, by carrying on as before.

What's been missing is a moral compass. Not any longer, thanks to Pope Francis's historic call for immediate action.

Two of us helped organise a non-sectarian symposium at the Vatican in 2014, commissioned by the Pontifical Academies of Science and Social Science. Physicists, chemists, biologists, earth scientists, economists, sociologists, philosophers and theologians were in attendance.

We conveyed the science: the knowledge that if we keep



pumping greenhouse gases into the air as we do now, by mid-century we won't need to read news bulletins about distant events to become aware of the dangers of climate change. Climate shifts due to human activity are already apparent in some parts of the world, and by 2050 everyone would experience them: as typhoons, severe storms, megadroughts, floods, heatwaves, beach erosion or sea-level rise depending on where they live.

The scale of change would become so large that climate disruption would be an established fact for all. But if we wait until then to take drastic action, it would be too late.

A complete halt to emissions after 2050 would help prevent the situation worsening further, but not take back the 2 trillion tonnes of accumulated anthropogenic greenhouse gases blanketing the

Turn it down

A mute button for real life? What a compelling and disturbing idea, says **Jamais Cascio**

FILTERING the deluge of data that enters our lives via the internet is something most of us have become used to. We can block adverts, automatically prioritise email, press mute on Facebook connections, and much more, controlling what reaches us. Now we're on the cusp of getting filters for our offline existence too.

The idea of augmented-reality glasses or lenses blocking unwelcome sights has fuelled imaginations for a while, but the first technology to allow us to blot out what we don't like may alter what we hear, not what we see.

A group called Doppler Labs is working on Here Active Listening. This combines digital earplugs

with a phone app to allow the enhancement or suppression of chosen sounds. This is not simple noise cancellation to block out the rumble of aircraft engines while listening to music, say. The device does not play music, instead, it has "audio curation tools" for suppressing traffic noise, chatter in the workplace, and even crying babies. The proposal clearly has appeal; the Kickstarter campaign to fund production passed its \$250,000 target in days.

'Critics noted an implicit class element in paying for the ability to blot out other people's lives in this way'

The idea of blocking what you don't want to hear is both compelling and disturbing. Busy malls and workplaces could be made more tolerable – but at the cost of not being able to gauge the true state of your surroundings.

Critics have also noted an implicit class element in paying for the ability to blot out other people's lives. This ambivalence will only grow as the technology improves. Political protests, styles of music, and even specific voices or words might one day be muted.

The desire to filter out what we find disturbing or unwelcome isn't new. Online, we can repel opinions, ideas or facts that don't

planet by then. They will linger for centuries.

We would have subjected generations unborn to a warmer planet, with chaotic weather unlike any witnessed for millions of years. The poorest would be hardest hit. Yet the three billion with the lowest incomes are responsible for less than 10 per cent of emissions.

The symposium concluded that we need a fundamental change in our attitude towards nature and towards one another, rich or poor, to achieve a solution.

Faith leaders have a particular moral authority to call for such a transformational change. We are fortunate to have a global moral leader in Pope Francis.

We think his powerful call for action "here and now" will have an impact on our collective awareness, an absence of which has led to our continual erosion of the natural capital we inherited, without concern for the poorest or future generations. ■

Veerabhadran Ramanathan is professor of atmospheric and climate sciences at the University of California, San Diego; Partha Dasgupta an economist at the University of Cambridge; and Peter Raven a botanist and environmentalist at the Missouri Botanical Garden in St Louis

match our views like never before. The "real world" has been the stubborn holdout, confronting us with things that we may find insulting, offensive or blasphemous. That is changing.

Audio curation, alongside augmented reality and facial recognition, will soon enable us to remove unwelcome day-to-day experiences. For some, there may be welcome benefits or relief. For those who worry about the health of civil society, there are also reasons to be troubled. ■

Jamais Cascio is a distinguished fellow at the Institute for the Future, California. He blogs at openthefuture.com

ONE MINUTE INTERVIEW

I got a call from a comet

After months of radio silence, Rosetta's comet-lander, Philae, woke up and called home, to the relief of **Cinzia Fantinati**



PROFILE

Cinzia Fantinati is the European Space Agency's operations manager for Rosetta's lander, Philae, which is sitting on Comet 67P/Churyumov-Gerasimenko. She is based at the German Aerospace Centre in Cologne

How were things at Rosetta mission control when Philae called home on 13 June?

We were of course hoping for Philae to wake up, but seeing it was great. We are really happy. The first data showed that the lander's status was not too bad.

What happened when Philae first touched the comet in November last year?

It bounced. Then it landed in a poorly illuminated area, so once the primary battery had discharged, its solar panels couldn't recharge the battery fast enough. Philae was forced to enter hibernation, and for seven months we couldn't communicate with it.

Did you think it would wake up as comet 67P neared the sun, giving Philae more energy?

Yes, but we had a lot of uncertainty: something might have broken in the meantime, or gases pushing out from the warming comet could have blown Philae away or blown dust on to its solar panels, rendering them useless.

Where were you when Philae woke up?

I was in Italy visiting my parents. As operations manager, I get the first call if we receive a signal from the lander. When I saw the number displayed on my phone, I knew something must have happened, so I was really excited. My parents watched me run around, trying to phone my colleagues, connect computers...

What's your dream science scenario for Philae, now that it's back in action?

The dream would be to see the lander's drill gather a sample of cometary material. The lander has more than 20 small ovens on a carousel. Each time the drill is used, it can take the sample and put it in an oven, which heats it to release frozen gases for analysis. The drill, ovens and mass spectrometer are energy-expensive, though, so we need to check the energy budget.

The comet comes closest to the sun on 13 August, so you're against the clock...

Not just the clock. As it nears the sun, the warming comet becomes more active, with more outgassing and dust flying off it. This means Rosetta will have to move further away, which could affect communication with Philae.

Why would Rosetta have to move away?

It navigates via a star tracker, which has been confusing dust for stars, making navigation harder. Each time that happens, Rosetta must move away until navigation can safely resume. Each day we try to get Rosetta closer to the comet, but it's a fight.

How will the mission end?

We expect Rosetta to finish its mission in September or October 2016. After that, its distance from the sun will be so great it will have to go into hibernation. We won't have enough fuel to restart after that, so at the mission's end we will park Rosetta on 67P. The plan is for it to slowly spiral towards the comet, doing science until the very last moment. It should be an interesting finale.

Interview by Sean O'Neill

More than just a breath of fresh air

Why is being in the country good for us? Perhaps because it's slightly poisonous, says toxicologist **Mike Moore**

"WE NEED the tonic of wildness... we can never have enough of nature," wrote Henry David Thoreau in *Walden: Or, life in the woods* – his 1854 account of living among nature. It turns out that Thoreau was right about the "tonic" of the natural environment. Evidence is mounting that, as many of us assume, being by the sea or in the countryside is good for our health. The question is why.

Some of the restorative effects of this "blue-green space" could be psychological. This stems from the biophilia hypothesis, put forward by the biologist E. O. Wilson in the 1980s, that we have a hardwired need to connect with nature. For instance, a study at the time found that just looking out of a window on to a natural scene helped patients recover more quickly after surgery than those whose view was of a brick wall.

Smell the difference

More recently, a UK study showed that people who live in coastal locations take significantly more exercise than those inland. And a Japanese study on physiological effects of *shinrin-yoku* – literally "forest bathing" – found that participants had lower blood pressure and lower levels of the stress hormone cortisol when they took country walks than when they walked city streets.

These are not the only ways in which the countryside could impact our health. Graham Rook of University College London argues that blue-green space improves the regulation of our immune system, because it exposes us to bacteria and parasites with which we

co-evolved. I have a new theory to add to the mix: the country and sea air is good for us because it is slightly poisonous.

Take a stroll by the ocean or in the woods, and you can smell the difference compared to a town or city. It's more than just a lack of pollution. What you are sensing is an airborne plethora of particles and chemicals produced by plants, fungi and bacteria.

Wave action produces microscopic droplets of seawater, bringing with them compounds from marine cyanobacteria, algae and seaweed. The presence of these biomolecules in the atmosphere represents a radical departure from the urban environment, which is more likely to contain synthetic pollutants and mildew.

Of particular interest to me are compounds called phytochemicals, derived from plants, algae and cyanobacteria. Some of these are polyphenols – antioxidants which often act as natural defences against pathogens and predators. Others are volatile terpenoids, which are responsible for the scents of plants. What is so special about these chemicals?

When I came across the concept of biophilia 10 years ago, I wondered if chemical factors in the environment might be responsible for the beneficial effects of nature. I now think that breathing in and ingesting these natural chemicals may have a positive effect on our physiology. They may even be able to block the progression of many diseases such as diabetes and cancer, as well as certain neurodegenerative processes (*Environmental Research*, vol 140, p 65).

During the course of human evolution our

PROFILE

Mike Moore is an environmental pathologist and toxicologist at the European Centre for Environment and Human Health at the University of Exeter, UK

Tiny doses of plant toxins in forest air could boost our health



ancestors were exposed to a legion of phytochemicals, through inhalation and their diet. Though many of these are toxic at high concentrations, this long-standing exposure made us tolerant to low doses. In fact, exposure to low levels of these toxins can be of benefit due to the mild stress they induce, which triggers repair mechanisms and enhances tolerance to bigger doses – an effect known as hormesis.



Some phytochemicals also appear to have biological effects similar to those of severe calorie restriction, which inhibits mTOR and has been shown to have health benefits for humans and increase lifespan in many animal species.

And mTOR may not be the only cell-signalling pathway targeted by these airborne molecules. Phytochemicals in food can influence other systems, such as the MAPK/ERK pathway which plays a key part in cancer progression, and AMPK, a protein which monitors the energy level of cells.

This "biogenics" hypothesis remains untested at the moment. It is uncertain whether the levels of bioactive chemicals in natural aerosols are sufficient to influence cell signalling, although my colleagues at the University of Exeter and I plan to study the effects of low concentrations of

"It is natural to ask: could we bottle the benefits of country and sea air?"

phytochemicals in mice. However, we already know that certain airborne phytochemicals can interact with cell signalling pathways to cause hypersensitivity in the immune system – giving rise to hay fever, for example – and that minute amounts of airborne algal toxins can induce asthma.

Planners are putting increasing emphasis on creating urban parks as ever more people move to the city from the country. But maybe there are other ways to bring the country to the city.

If it turns out that airborne natural molecules do indeed boost our health, then this leads to the question of whether we could "bottle" the benefits of country and seaside air. Natural phytochemicals could be added to aerosols for use in the home and in public spaces such as shopping malls. They could even be added to our diet.

The modern built environment represents a significant change of airborne milieu for humans. City air is not only more polluted but lacks the diversity of biologically derived molecules that humans have been exposed to throughout our evolutionary history. In light of this, any health benefits we experience in the natural environment should perhaps be regarded not as a boost to well-being but as a return to our baseline state.

It seems that when we venture out to "take the air", we get a great deal more besides. ■

Abundant evidence exists that dietary phytochemicals have this beneficial hormetic effect, particularly the antioxidants found in many vegetables, fruits and medicinal plants. If eating food containing these substances is good for us, such as in the Mediterranean-style diet, then ingesting them via an airborne route may also be beneficial.

How exactly could these chemicals boost health? By inhibiting an important system,

the mTOR pathway, that controls many aspects of cell function and growth.

When this signalling system is overactive, it can lead to diabetes, inflammation, certain cancers and neurodegeneration. Inhibiting the mTOR pathway activates a number of protective systems such as tumour suppression and autophagy – the destruction of damaged cellular components, allowing new ones to form.



Stop all the clocks...

With the latest leap second due, is it time to rethink the cumbersome way we measure time, asks **Michael Brooks**

ROGER PENROSE appears baffled by my tardiness, eyeing my sweat-beaded brow with what I can only assume is pity.

"I found it very easily," says the University of Oxford mathematician. "It's a straight walk up from South Kensington tube." The irony is not lost on either of us. I had not only arrived late to a meeting about time measurement; I had got lost on the streets of west London trying to find the Royal Institute of Navigation.

That was last year, at the first gathering of a committee to oversee the world's first public consultation about leap seconds. It was to be

Penrose's only appearance: after half an hour he pulled out, suggesting the committee was skirting the real problem with time.

The latest leap second will occur at the end of Tuesday, 30 June. It is the first time since 2012 that the world's time lords have decreed the clocks must stand still for a second, to ensure that time measured by Earth's spin and time measured by atomic clocks do not get out of sync. The UK government's consultation was intended to inform an international debate, due to come to a head later this year, about whether it should be the

last time. Proponents of leap seconds argue that they represent a historical connection between astronomical motion and the passage of time that should not be broken. Opponents think the leap-second system is hopelessly muddled and not fit for purpose in our fast-paced, networked world. Not, as I was to find out, that there is much agreement on what should replace it.

Leap seconds are a response to the capricious way Earth spins. A day is the time Earth takes to rotate once on its axis, and the original definition of the second was 1/86,400



...and then start them again

of that day. But a day is not always precisely the same length. The gravitational pull of moon and sun are gradually slowing down Earth's spin, so 100 years ago, the day was a little shorter. Instabilities due to atmospheric effects and Earth's roiling molten iron core also mean the planet's spin can slow down or speed up in unpredictable ways.

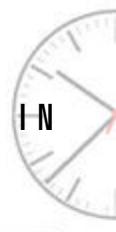
Such inconsistencies are partly why, in the 1960s, the world embraced a new definition of the second. It was based on atomic physics: specifically, the duration of 9,192,631,770 cycles of one particular resonance of a

caesium-133 atom. But that number of cycles was still chosen to correspond to the length of a second in an average sort of day in the 1950s (see "Every second counts", page 33). Soon, as the days imperceptibly lengthened, corrections were needed to stop atomic time and Earth time drifting apart. So in 1972, the leap second system was born.

And it remains how time is made today. The astronomers of the International Earth Rotation and Reference Systems Service (IERS) track Earth's rotation using the most stringently fixed reference point they can

find – not the sun these days, but light from active galaxies known as quasars billions of light years away. When a variation in Earth's spin threatens to send this Universal Time (UT1) more than 0.9 seconds astray from the ticking of atomic time, the IERS issues a call, in a document known as "Bulletin C", to add or subtract a leap second (see diagram, page 32). So far, the order has always been to add.

The result is Coordinated Universal Time, or UTC, the standard time administered by the International Telecommunications Union of the United Nations (ITU). And so on 30 June ➤



this year, the clocks will briefly (at least officially) stand at 23:59:60. Depending on how much your local time is ahead of or behind UTC, the actual event will seem to happen earlier or later, of course. In the UK, which is currently on UTC+1 summer time, it will happen at approaching 1 am on 1 July; in Australia, it will be some time mid-morning.

This is a highly contentious fudge. Felicitas Arias heads the group at the International Bureau of Weights and Measures (BIPM) in Paris that combines astronomical and atomic time to make UTC, and then passes it to the ITU for dissemination. "The present UTC system with leap second adjustments is outmoded," she says. "But more than that, it creates difficulties on systems needing of a very precise time synchronisation."

Certainly, technology companies are among the system's most vocal critics. Attempts to tweak systems to deal with past leap seconds have caused a few isolated cellphone blackouts. In the first seconds of July 2012, the reservations system used by the airline Qantas crashed as a result of a leap second that had just been added.

A glitch in time

As software becomes ever more complex and interdependent, dire warnings are multiplying of air-traffic control computers malfunctioning or military missiles misfiring. A submission to the UK Leap Seconds consultation, made in a personal capacity by Demetrios Matsakis, head of time services at the US Naval Research Laboratory, argued that the effects have been underplayed. "No one can tell you how widespread the issue is because most businesses and institutions do not volunteer information about mistakes," he wrote, continuing that leap seconds have disabled GPS receivers and other similar systems. A fatal consequence of leap seconds is "unlikely but conceivable", he concludes.

Not that this gloomy view is unchallenged – and some foresee problems if we abandon leap seconds. The Russian satellite navigation system GLONASS, for instance, takes leap seconds as a given, and would be difficult to reprogram if they were ended. And can leap seconds really pose that much of a challenge to 21st-century tech whizzes? "Leap seconds present some interesting but ultimately simple-to-solve problems," shrugs Anthony Flavin, who is responsible for making sure the systems of the British telecoms company BT incorporate them without a hitch.

Markus Kuhn, a computer scientist at the

Computing

33,860,000,000,000,000,000

CALCULATIONS PERFORMED BY THE WORLD'S FASTEST COMPUTER

6,000,000,000,000,000,000

BYTES OF DATA COLLECTED BY THE LARGE HADRON COLLIDER

2,393,470

EMAILS SENT

48,745

GOOGLE SEARCHES

Life and environment

1120 tonnes

GLOBAL CARBON
DIOXIDE EMISSIONS

11

TREES CUT DOWN IN THE
AMAZON RAINFOREST

600,000

CHEMICAL REACTIONS CATALYSED BY THE
FASTEST ENZYME, CARBONIC ANHYDRASE

10

NUMBER OF UNFAMILIAR FACES YOU
CAN FORM A SNAP JUDGEMENT OF



ONE SECOND

Money

\$3.4 million

VALUE OF ALL GOODS AND SERVICES PRODUCED IN THE GLOBAL ECONOMY

\$402

INCOME OF WARREN BUFFETT, THE WORLD'S HIGHEST EARNER

0.00144 ¢

INCOME OF SOMEBODY ON THE GLOBAL POVERTY LINE

People

4.3

PEOPLE ARE BORN

1.8

PEOPLE DIE

Distance

299,792 km

TRAVELED BY A PHOTON IN A VACUUM

200,000 km

TRAVELED BY THE SOLAR SYSTEM IN ORBIT AROUND GALACTIC CENTRE

29,800 km

TRAVELED BY EARTH IN ORBIT AROUND THE SUN

7700 km

TRAVELED BY THE INTERNATIONAL SPACE STATION IN ORBIT AROUND EARTH

16.26 km

TRAVELED BY NEW HORIZONS, THE FASTEST SPACECRAFT EVER, NOW ARRIVING AT PLUTO

University of Cambridge, is similarly bullish.

"The case for abandoning the leap second is overstated," he says. Plenty of countries fiddle about with time, for example by adding in daylight saving. "Computer systems and smartphones receive those revisions as part of normal security updates," he says. "The operating system industry has long figured out how to update these things routinely."

The first gripes about leap seconds were heard in 1999, after IERS started a discussion about their use. They have continued ever since. In 2012, the ITU leap-second group suggested getting rid of them, but couldn't reach consensus. The group then suggested a compromise: insert a leap hour at some point in the future. That idea seems to have made things worse. "It really annoyed me," says Kuhn, who was in on the discussions when the US first floated the idea of a leap hour in 2003.

For a start, there's the question of who would be responsible. "The first one would be about 600 years off, which is unrealistic enough, but it would also be 3600 times more disruptive than a leap second," he says. "The problem of inserting a UTC leap hour is probably vastly more complicated than the Gregorian calendar reform." The US proposal, he thinks, was just an attempt to get rid of leap seconds by the back door. "It was somewhat dishonest and not carefully thought through," he says.

In the end, ITU member countries chose to postpone a decision until this November, when the World Radiocommunication Conference meets in Geneva, Switzerland. Dennis McCarthy, who once revelled in the titles of science adviser to the director of the Directorate of Time and head of the Earth Orientation Department at the US Naval Observatory, is not confident of a resolution. "I would hope that it will be laid to rest this year, but I suspect that it could also drag on for a while," he says. Arias is more optimistic, but doesn't know how the pendulum will swing. "It is difficult to make a prediction," she says.

At present, the US, France, Italy and Germany are in favour of ending leap seconds. The UK, Canada and Russia want to keep them. But things change: the UK used to be alone in loving the leap second; Germany and China have changed their position at least twice.

Since the ITU insists it needs consensus, we remain in leap-second limbo. In 2012, at the most recent ITU meeting, David Willetts, then the UK minister responsible for science – and therefore, at the time, time – was challenged to justify his position. He said the British public wanted to keep the traditional link between ➤

astronomy and time. He was asked what evidence he had for this. Hence the public consultation, and why both Roger Penrose and I found ourselves in South Kensington last year.

At first glance, it is hard to see why any member of the British – or any other – public should care. If we were to scrap leap seconds, by 2100 we'd be 2 to 3 minutes out of sync with the sun, and about 30 minutes out in 2700. On the first day of 2014, the sun rose on my house at just after 8 in the morning. Without any adjustment, it will eventually get closer to 9 –

"Time's traditional link to the sun and the stars should not be dismissed"

but only in about a millennium's time. Is it even possible to have an opinion about this?

Yes, says Kuhn. Leap seconds were accepted in the 1970s because of a cultural assumption of a close connection between human time and Earth's orientation in space. Nothing has changed, he says, and time's traditional link with the sun and stars shouldn't be dismissed just because we are told we are living in a high-tech age. "Timekeeping is an astronomical affair," he says.

James Ladyman, a philosopher of science at the University of Bristol, UK, agrees. "There is something culturally important about recognising that the day isn't an arbitrary unit of time," he says. "We have this historic connection between timekeeping and astronomy and the behaviour of the Earth, and we should subordinate our timekeeping to those natural phenomena. There's something symbolic about saying there's a determinant of things in the universe that isn't just the power of money. What's the real cost – a little bit of hassle for Google?"

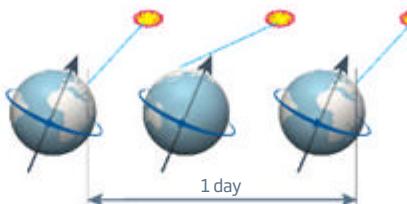
In fact, Google says it isn't a hassle. The company, which was involved in the UK public consultation, said it has worked out how to adjust its servers' clocks with minimum disruption. But every company currently decides on its own how best to do that. Google smears out the extra second over the previous few hours, whereas BT sticks with adding in an extra second. "We deal with the leap second by including it correctly," says Flavin. "The last minute of the relevant day will have 61 seconds." BT's beloved dial-up speaking clock will add in an extra second's pause before its third "pip" to take account of it.

Making time

Natural variations in Earth's rotation mean that time measured by atomic clocks must be adjusted to agree with astronomical time. This gives us Coordinated Universal Time (UTC)

Universal Time (UT1)

Astronomers measure the time between distant galaxies appearing at the same angle in the sky



1 UT1 second =

1 day divided by 86,400

23:54:57.00

International Atomic Time (TAI)

Physicists measure oscillations of the outer electron of caesium-133 between two energy states



1 TAI second =

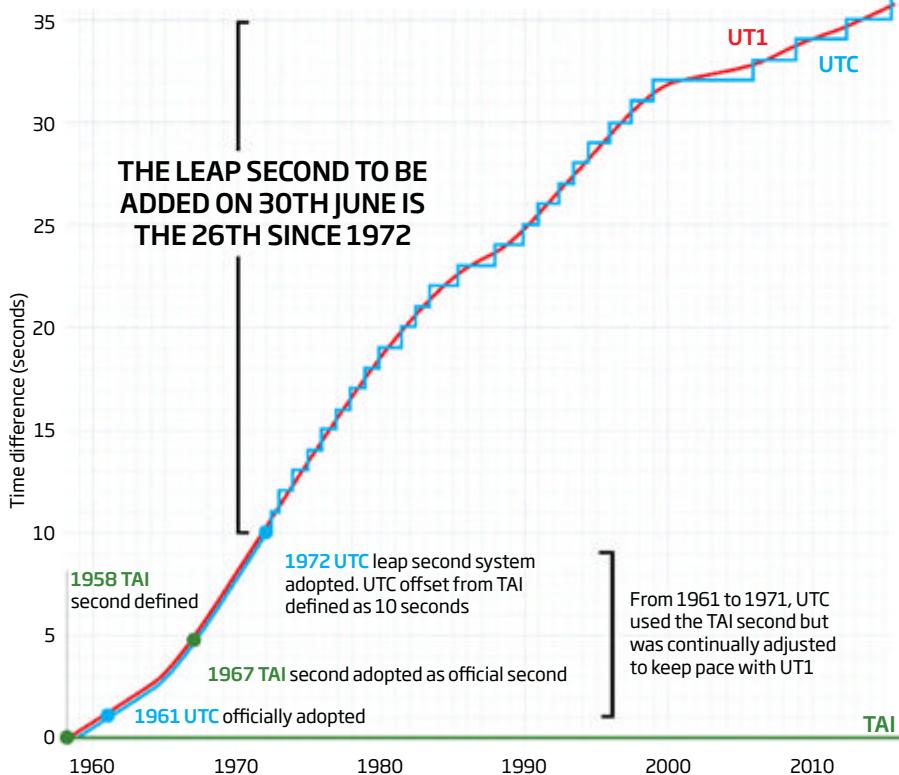
9,192,631,770 oscillations

23:54:57.89

Coordinated Universal Time (UTC)

UT1 tends to get behind TAI as Earth's rotation is slowing. If $TAI - UT1 > 0.9$ seconds then a LEAP SECOND IS ADDED

As a result UTC has been gradually drifting away from TAI



Every second counts

The concept of dividing the day into smaller units goes back to the Bronze Age at least, but the invention of the modern second is usually attributed to Persian polymath Al-Biruni around the end of the first millennium AD. He took the hour - a unit of 1/24 of the day already used by the Greeks and Sumerians among others - and subdivided it twice by 60. Latin scholars later christened the second of these units "secunda", corresponding to 1/86,400 of a day.

By the mid-20th century, it was clear that fluctuations in Earth's rotation meant day length varied too much to define the second consistently. Even the "mean solar day", the average duration of a day over a year, wasn't accurate enough. And so time itself was reinvented. "It's an extraordinary story, but also

extraordinarily complex," says Rory McEvoy of the Royal Observatory Greenwich in London.

WOBBLY TIME

In 1960, after years of debate, the International Committee for Weights and Measures agreed on a new definition of the second starting from the length of a "tropical" year - the time it takes for the sun to return to exactly the same position in the sky, say from one summer solstice to the next. (Owing to a slow shift in the angle at which Earth spins, this is not quite the same as the time it takes the Earth to orbit the sun.)

Unfortunately, Earth's spin axis also wobbles as it shifts, leading the tropical year's length to vary, too. The committee nailed it down to a specific year starting at noon GMT on 31

December 1899 (for their purposes "0 January 1900"). According to meticulous calculations made back then by mathematician Simon Newcomb, this lasted just shy of 365 days, 5 hours and 49 minutes - 31,556,925.9747 seconds, in fact.

But hang on a second: to make that last conversion, Newcomb had to assume the second had a set length. And where did he get that from? In the old-fashioned way, by subdividing the mean solar day in 1900 into 86,400.

This complex, somewhat circular reasoning created an unvarying unit, but for practical purposes it was not much use; there was no easy way to get a physical clock ticking to exactly this tock. So in 1967 the committee jumped again and adopted the "atomic second", defined by a specific number of atomic vibrations: to be

precise, "9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom".

But that time corresponded to the length of 1/86,400 of a good old solar day, derived from observations made between 1952 and 1958. Nonetheless, 1967 is seen as a decisive break in the historical link between astronomy and time. "It's the critical decision that moves from the astronomical to the atomic timescale," says McEvoy.

Though the atomic second is being measured with ever greater accuracy, that definition still stands. So the fundamental unit of time remains tenuously linked to the duration of a day - albeit an average day in the mid-1950s. Graham Lawton

So leading up to the 30 June leap second, different companies' clocks will be telling very slightly different times. That's a potential problem when it comes to time-stamping legal documents or financial transactions, and could in theory allow someone to game the markets, say. "I'd like to see a standardised way for computers to move through a leap second," Kuhn says.

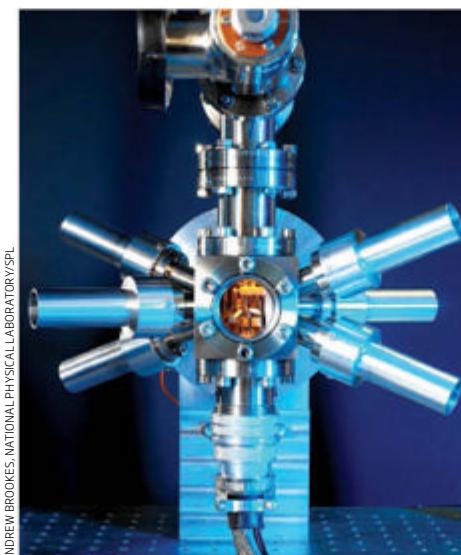
He advocates another reform, however: running two time systems in parallel. International Atomic Time (TAI) is the caesium-based time system that has been ticking away without adjustment since the late 1950s. It is an average of the oscillations of over 400 atomic clocks around the world, and thanks to leap seconds is now running 35 seconds ahead of UTC - after 30 June, make that 36 seconds. A sensible step, Kuhn thinks, would be to allow the use of TAI in systems that only need to measure the passage of time, not what the time is. Some systems already do this - some power companies, for example, use TAI to coordinate the output from their generators. But at the moment, that's not easy to do. Although TAI feeds into the calculation of UTC, it is not itself widely disseminated.

For Penrose, such fiddling doesn't go far enough. He thinks we need to stop time and start again. He wants us to define a universally agreed zero of time, then adopt a time system he has named "T" - simply the number of seconds after that zero. "I'm proposing that both TAI and UTC be abandoned as universal standards," he says. "Surely just

using the number T is much simpler?"

He advocates using the metronomic bursts of radiation that reach us from fast-spinning neutron stars called pulsars to mark out T, so that we retain a link to astronomical time. Each country would then decide how it wants to define time for its citizens' everyday use - and whether to shift its clock with leap seconds. There won't be any confusion because it will simply publish its chosen public time relative to T, just as it does

Should the world finally tick to the tock of only the atomic clock?



with daylight saving times relative to UTC. Computer-based clocks, meanwhile, can work simply from T without interruption, whether or not a leap second comes along. "I would hope that the UK adopts a leap second into its system, but I wouldn't get too worked up if it didn't," says Penrose.

Going by the results of that consultation, published in September last year, the UK is likely to still be defending the leap second. In general, technology companies followed Google's line and said losing the leap second would make their lives easier, but that they can - and do - cope with it. A standardised technique, particularly if accredited by the ITU, would be helpful. Religious groups shrugged their shoulders; losing the leap second wouldn't affect their prayer times or festival dates. As far as the general public were concerned, the report noted that they "were divided between those who were indifferent to the issue and those who wanted to maintain clocks in time with the sun".

Indifference seems to be the international reaction, too: no other country has expressed any interest in the UK's public dialogue. In the meantime, in the inscrutable way of government, responsibility for the UK's time has passed from the minister for science to the minister for business.

Does that signal a turnaround in official attitudes - and if so, does that mean the leap second's time is up? Only time will tell. ■

Michael Brooks is a consultant for *New Scientist*



Damsels in control

Females can be just as competitive and aggressive as males about reproduction. Why has it taken more than a century to work that out, asks Tim Vernimmen

AFTER publishing *On the Origin of Species*, Darwin was worried. "The sight of a feather in a peacock's tail, whenever I gaze at it, makes me sick!" he confessed in a letter to a colleague. His theory of natural selection, he realised, couldn't explain why the males of some species have evolved such preposterous ornaments or why others have elaborate armoury. He needed another idea.

And so the theory of sexual selection was born. Males have weapons, Darwin proposed, to fight over females, and their bright colours, fancy songs and adornments were to seduce the reticent sex into mating. "The female, on the other hand, with the rarest exception, is less eager than the male," he wrote. "She is coy, and may often be seen endeavouring for a long time to escape from the male."

Many of Darwin's ideas caused great controversy among his Victorian contemporaries. But his ideas about sexual selection raised few eyebrows. The image of vigorous males competing for aloof, disinterested females fit the mindset of the time – at least that of men. Women's opinions were rarely heard; few attended universities, let alone formal scientific meetings. But one did make a stand. Darwin's French translator, Clémence Royer, noted that woman is "the one

animal in all creation about which man knows the least". She also complained that science had been "exclusively made by men" and had "considered woman too often an absolutely passive being, without instincts or passions, or her own interests".

Times have changed, but sexual selection theory has been slow to catch up. For a century, the idea gradually went out of fashion among biologists. Then, when interest began to revive, most of the new thinking was around males and whether they might use strategies other than fighting or flaunting to secure a female. There was talk of "mate guarding", "sperm competition" and "ejaculate economics". But the notion that males compete and females choose remained.

"Undoubtedly, sexual selection has had a male bias," says Geoff Parker at the University of Liverpool, UK, who helped bring Darwin's theory out of obscurity. "Although I did warn early on that we should not see females as passive vehicles, I think I have been guilty of this too." That bias is now being redressed, because evidence gained in recent years reveals that females, far from being coy, are just as keen on sex, and are equally competitive and aggressive – if the need arises.

As far back as the Ancient Greeks, people

were aware that female animals might have sex with multiple partners. Aristotle noted that among chickens – seemingly the quintessential example of a dull harem dominated by a single sexy male – hens can mate with several cocks, a behaviour known as polyandry. So why did it take science so long to pay attention? For a start, the hen's sexual antics are subtle. "Cocks openly fight and their crowing may be the first thing you hear every morning, while it's much harder to figure out the pecking order among hens or catch them sneaking away to mate with other males," says Tom Pizzari at the University of Oxford, who studies polyandry in the chicken's wild ancestors. "But that doesn't rule out a certain sociocultural bias in science."

When the cock's away

"When it comes to polyandry, I would agree that there's been some wishful thinking, taking our own lofty norm to be the rule in nature," says evolutionary ecologist Hanna Kokko at the University of Zurich in Switzerland. And hens aren't the only birds we have misjudged. In the 1980s, technological advances shattered our illusions. "DNA fingerprinting made it possible to find out who'd fertilised the eggs," says Kokko. "Many were shocked to discover that female birds weren't faithful to their mates." That birds should be revealed as promiscuous was particularly telling because about 90 per cent of species pair up, at least for the breeding season. Nevertheless, the DNA showed that as many as a fifth of the eggs produced by apparently monogamous females weren't sired by their regular partner.

Following this unequivocal evidence of multiple mating, biologists have come to recognise that polyandry has many benefits for females. In birds, they may be hedging their bets, trying to obtain better genes for their offspring while retaining the services of a faithful male to help look after their chicks. And in fish, where fertilisation normally happens outside a female's body, and eggs

89%

Animal populations with polyandry

1 in 5

Chicks fathered by cuckoldry

may need to be guarded from predators, one male fish can take care of the eggs of many females. "That leaves females free to mate with several males, while males can be sure that they are investing time in their own broods," says Suzanne Alonzo at the University of California, Santa Cruz.

Polyandry doesn't just bring childcare and good genes, it can have more immediate rewards, too, such as nutritious gifts from males to enhance fertility. There's even speculation that the same genes cause promiscuity in males and females alike. It's no wonder it is common among invertebrates and widespread in vertebrates, including mammals. Given its prevalence, Kokko suggests, it would make more sense to consider having multiple sexual partners as standard for both sexes, and monogamy as the exception requiring explanation. "When you think of it, simply mating every time you meet an attractive male seems a much more straightforward strategy than mating once and then losing all interest," she says.

But if females are just as eager to mate as males, why do they often lack ornaments and weaponry? It mostly comes down to differences in reproductive biology. Because females tend to invest more heavily and for longer in producing offspring, the number of males that are ready to mate is usually higher, so competition for mates is more intense among males. That is especially the case when breeding females live in groups that individual males can monopolise. "Male deer, for example, have a lot to gain from winning fights – they may not get any matings if they don't," says Tim Clutton-Brock at the University of Cambridge. "Females, on the other hand, have a lot to lose – they'll mate anyway, so why risk injuries?"

But successful reproduction is about more than scoring some sperm. Females also need resources to raise their offspring. And here things can get physical. "If the competition for food or nest sites is unusually intense, females can be the more aggressive sex," says Clutton-Brock. "We see that in clownfish competing for anemones in which to live, in certain parrots vying for nest holes, and in meerkats." He has spent decades studying meerkats in the



Kalahari desert. Predation is common there and food is hard to come by, so adults group together to raise young, and females are stronger and fiercer than males. Some 90 per cent of infants descend from the dominant male and female. As a result, competition between females for the top spot is intense.

Sing when you're winning

Among female birds, competition for resources can also be fierce. A nestful of chicks requires a lot of feeding, which is why a male and female commonly share the responsibility. But females can steal a march on the competition by getting a prime site to nest and forage in. To do this, they use a ploy that is normally associated with males: they sing. "In almost a third of all bird species, females sing, though they generally do so to defend a territory, not to attract mates," says evolutionary ecologist Joseph Tobias at Imperial College London. "Especially in the tropics, where competition for territories is

very intense, both sexes often sing together."

All this leaves no doubt that reproductive competition can be just as intense between females as males. Out-dated sexual attitudes may partly explain why it has taken some biologists so long to come to terms with this. But there are practical reasons, too. "Not only is the frequency and intensity of female aggression usually lower," says Clutton-Brock, "but females are also much harder to recognise individually, because there are often many more females than males around, they tend to look more similar, and they often do not exhibit any obvious scars." Also, field studies are needed to compare the long-term reproductive success of females.

Now that we are starting to overcome these issues, some believe we need to overhaul Darwin's theory of sexual selection. "Sexual selection is broken, it's worthless and it's harmful," says ecologist Joan Roughgarden of Stanford University in California. She favours the idea of social selection, based on group behaviour rather than that of individuals.

90%

Bird species that form "monogamous" bonds

8

Average lifetime sexual partners, women

12

Average lifetime sexual partners, men



MARK MOFFETT/MINDEN PICTURES

Competition between female jumping spiders is very physical

But most think the theory needs evolution not revolution. Clutton-Brock, who was among the first to call for sexual selection to include female-female competition, says: "What's happened in the last 20 years or so is that scientists, including us, have been focusing on exceptions. Those are very interesting, but we should not forget they are exceptions." What these exceptions do give us, however, is a more balanced view of the mating game – one that may even shed light on our own behaviour.

Consider our closest cousins, chimpanzees. "While males are forming coalitions, females are often by themselves, and compete for exclusive access to fragments of forest where lots of food can be found," says Anne Pusey, who studies chimps in Gombe National Park, Tanzania. Overt aggression is rare, but infants are at risk of being killed by females who aren't their mothers. There is one situation in which competition is inevitable. "Male chimps don't migrate – they'd simply be killed when found in the forest all by themselves," says Pusey. "Females usually do, and immigrants are under relentless attack by the other females until a male steps in to protect the cute new girl on the block."

That is similar to what may happen when competition for partners and resources becomes intense in humans, says psychologist Anne Campbell at the University of Durham, UK, who has studied aggression between

Sisters are doing it for themselves

Throughout history and across the globe, many cultures and most world religions have tried to impose lifelong monogamy – on women, at least. "Female monogamy is enforced in most so-called patrilineal societies, where wealth can be easily accumulated and only men inherit from their parents," says Ruth Mace at University College London. "In that case, it's quite important to make sure your heirs are your sons and not someone else's." Among the hundreds of societies that exist today, just a few dozen are matrilineal, with daughters inheriting.

COMPETITIVE PARENTING

In recent years, Mace has been studying one such group, the Mosuo of south-western China. They live in communal households, with a matriarch and several generations of her family under the same roof.

Traditionally, women may have a series of sexual partners. But no matter how long-term the relationship, the men remain in their own family homes, where they help care for the children of their sisters and nieces and may never pay much attention to their own offspring.

women in US inner-city gangs. "Good male partners can be very thin on the ground [in these areas] – male mortality is high, many men end up in jail, and the ones who are successful will often leave the neighbourhood," she says. Here the most desirable men are often gang members who have money and status. "They can provide for their girl, but since they're spoilt for choice, they can also afford to treat the girls quite abusively," says Campbell. "Yet, because of the intense competition for male partners, girls tend not to band together to teach those guys a lesson, but take it out on each other – especially on the new girls."

Campbell's work has upset some evolutionary psychologists and those who believe that the world would be at peace if women were in



PATRICK AVVENTURER/GAMMA

In this matrilineal society, family wealth, which comes mainly from farming, stays within the household. Nevertheless, sisters must share these limited resources if they are to reproduce, and this puts them in competition with one another.

Mace's analyses of historical and current data describing all the births and deaths in Mosuo families show that the more older sisters a woman has, the fewer children she will produce. How this "reproductive competition" actually unfolds is unclear. "Infant mortality is low, harmony is considered very important, and family relations appear quite peaceful, so it's probably something rather subtle," says Mace. "Like most people, the Mosuo don't like to answer indiscreet questions about their sex lives."

Matriarchs rule the roost and inherit the family wealth among the Mosuo in China

charge. She takes a more detached view. "Even though biology may help us understand where some of our more unpleasant tendencies come from, it never prescribes how things ought to be," she says. "On the contrary, I think understanding why people may feel or act this way may help us to deal with it."

And the same goes for men, of course. "If anything, biology discourages me from being too much of a dominant male," says Clutton-Brock. "You see male behaviour all the time that is unnecessary and unpleasant, in animals and elsewhere. We should be able to do better than that."

Tim Vernimmen is a freelance science writer based in Antwerp, Belgium

Brain under siege

The body's immune system is designed to make us hide away when we get sick. Could this also cause depression? Dara Mohammadi reports

MIKE had struggled with depression his whole life, but one day in 1995 it all got too much. "I completely fell apart," he says. "I backed out of life."

Mike tried to kill himself with an overdose of prescription painkillers. Medics saved him, but the next 15 years of treatment brought little respite. He cycled through dozens of types of antidepressants, with side effects including sickness, insomnia and anxiety. Nothing worked.

Then, in 2010, Mike received a call from his doctor, offering him the chance to take part in a clinical trial. Rather than targeting brain chemistry, as most standard antidepressants do, this was a trial of a drug normally reserved for Crohn's disease, an inflammatory bowel condition where the body's immune system attacks the gut. Desperate for a break, he signed up. And it worked. About a week after the first treatment, the fog of depression cleared. "I just sort of woke up," Mike says.

This trial is one of a growing number of studies probing the idea that the inflammatory response, which normally helps us when we get sick, might occasionally wreak havoc in the brain. It has been implicated in a number of disorders – from depression to schizophrenia and Alzheimer's disease.

That such a well-understood physical process might lie behind these brain disorders is a cause for optimism – turn off the inflammatory signals in the body, and you might be able to modify or even banish the symptoms in the brain. Even better, there may be readily available drugs that could help. "There is growing awareness that neuro-inflammation seems to play a role in a variety of psychiatric and also neurodegenerative disorders," says Claudia Buss at the Charite-University of Medicine in Berlin, Germany. "Anti-inflammatory treatments may have a great potential in treating them."

We're all too familiar with the lethargy and low mood that sweep over us when sickness strikes, driving us to curl up under a duvet.

These are the effects of inflammation, the first line of defence in the body's two-pronged response to infection or injury.

On detection of a harmful stimulus, macrophages, a type of white blood cell, release signalling molecules called cytokines. These signals of inflammation rally other immune cells to the scene to help fight infection or repair damage. They also make their way to the brain, which has a separate immune system to the rest of the body, divided by the blood-brain barrier.

The signals trigger neuro-inflammation, which is where microglial cells come into play. These are macrophage-like cells in

If the immune signals keep coming, the brain keeps us feeling miserable

the brain that secrete further cytokines to bring about "sickness behaviours": low mood, loss of appetite and lethargy.

This all makes sense from an evolutionary perspective – if our early ancestors felt tired and miserable when they were poorly they'd be less likely to leave their caves, and therefore to spread germs or pick up another infection while the immune system was compromised.

But there is reason to think that this protective system is not coping so well with modern life. Diseases like diabetes cause constantly elevated levels of inflammation. Obesity and stress also trigger it. All of this bombards our brains with low-level signals that we should be feeling under the weather. "The brain is still operating with this ancient instruction manual," says Charles Raison, at the University of Arizona. "It receives the signals and perceives them as an immediate threat to survival. So if the signals keep coming the brain keeps us feeling miserable."

The link between depression and inflammation is not in itself new. People who have diabetes, which Mike has, or rheumatoid arthritis, are known to have elevated baseline levels of inflammation and to also be at higher risk of depression. In the US, people with diabetes are twice as likely to have depression as the average person.

About a third of people with depression also have higher than normal levels of inflammatory cytokines in the blood, and most of these people don't respond to standard drugs.

Further evidence for the link between inflammation in the body and disease in the brain came last year with the first study to measure inflammation in children and see what happened when they grew up. By the time they were 18, those who had high levels of inflammatory markers in the blood when they were 9 years old were significantly more likely to have had bouts of depression, or a psychotic disorder like schizophrenia.

The obvious question, then, is whether drugs that work to dampen the inflammatory response could also help to treat depression.

The trial that Mike enrolled in, led by Raison, is one of a handful of studies testing that idea. The drug being trialled was infliximab, a powerful anti-inflammatory already used to treat Crohn's disease. It works by blocking the action of an inflammatory cytokine called TNF-alpha.

Mike was one of the 60 participants, who all had treatment-resistant depression. Each received three intravenous infusions of either infliximab or a placebo over 12 weeks.

At first, the results seemed disappointing; there was no difference between groups. But then Raison's team homed in on just the participants who'd started off with high levels of inflammation. In these people, infliximab did significantly better than placebo in terms of improving symptoms such as low mood, fatigue, anxiety and thoughts of suicide.



Mike was one of them, and since his treatment with infliximab, he says his depression has been much more manageable. "The idea that I was thinking about killing myself seems so alien that it could have been another person," he says.

By Raison's own admission, the study was small and his findings need to be substantiated by others. And an important complication casts a shadow on what might otherwise be a cause for celebration: patients with normal levels of inflammation seemed to do worse after infliximab treatment.

This shows that increased inflammation is not a contributor in all people with depression, says Raison, and that blocking it in patients with normal levels can be harmful: "People rush to put all inflammation in one pot, but at low levels it might be doing something good."

Mike had a clear suspect for his elevated levels of inflammatory cytokines – his diabetes. But there is another aspect of modern-day life that increases inflammation and that is psychosocial stress.

Over millions of years of evolution, stress has been a good indicator that the body might be wounded. So in response to stress hormones such as adrenaline and cortisol, macrophages secrete cytokines to pre-emptively ramp up inflammation and prepare the body for a possible infection.

"Before, you'd only get stressed if you had a lion chasing you or if you were starving and had to hunt," says Carmine Pariante, a psychiatrist at Kings College London, who

"Childhood trauma can hard-wire the immune system to run high for a lifetime"

studies the link between the immune system and depression. "Now we get stressed because of traffic or because our boss shouts at us. None of these wounds us physically, so we don't need inflammation. But it's still there, working away on our brain."

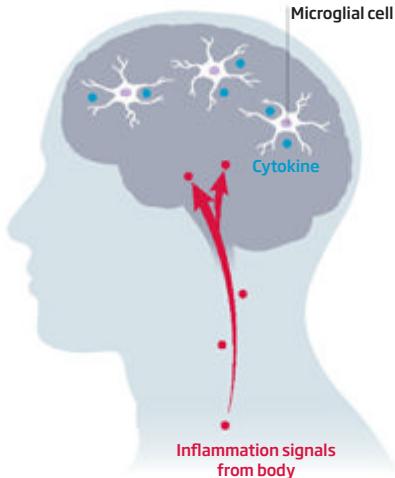
Since most people are exposed to these kinds of everyday stressors, why should they cause depression in only some of us?

Pariante thinks that, although stress, diabetes and so on can cause inflammation to spike in anyone, it's only the people with high baseline levels of inflammation who tip over into depression. People can have high baseline levels for several reasons: their genes might

In sickness and in health

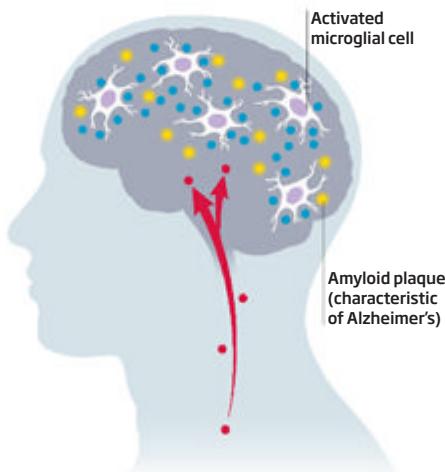
An over-active immune system could contribute to the symptoms of Alzheimer's disease

Healthy brain



Infection or injury causes inflammation, which sends signals that activate microglia – immune cells in the brain. These secrete molecules called cytokines, which promote "sickness behaviours": feeling lethargic, low mood, loss of appetite...

Alzheimer's brain



The plaques that are characteristic of Alzheimer's disease mean microglia are already activated. Inflammatory signals from an infection, stress, or chronic disease cause them to secrete cytokines at toxic concentrations that kill off neurons

predispose them to mount an over-sensitive inflammatory response. Or perhaps something happened during their early development to ramp up the dial.

We know that trauma during childhood such as physical or mental abuse can increase the risk of both physical and mental illness later in life, including depression, anxiety and post-traumatic stress disorder. The mechanism at play is still poorly understood, but Pariante is one of a group of psychiatrists who think that trauma when a child's mind and body are still developing can hard-wire the immune system to run high for a lifetime, presumably as an adaptation for living in dangerous environments where there's a high risk of injury.

Childhood trauma

Strong evidence for this comes from the Dunedin cohort study, which continues to follow more than 1000 people born in 1973. Pariante analysed the data, and found that those who were abused or neglected as children tended to have much higher levels of inflammation than those who'd had a stress-free childhood. Pariante has also just published a review of 25 studies that found childhood trauma had a significant impact on markers of inflammation in adulthood.

Again, Mike's story fits the script – he was physically and sexually abused as a child, and spent much of his youth bouncing between different foster families.

Inflammation might play a role even earlier still, during development in the womb. Last year, Buss presented a study at the Society for Neuroscience meeting in Washington DC, in which she found that babies born to women who had high levels of inflammation during pregnancy tended to have weaker connections in the brain, which might predispose these children to mental illness later on. The brain area affected was the default mode network, where weak connections are implicated in a number of psychiatric conditions in adulthood, including ADHD, autism, schizophrenia and depression.

Inflammation is also now thought to play an important role in Alzheimer's disease (see "Inflamed in the brain", p 19), but its precise contribution to these complex conditions, which seem to have multiple causes, remains poorly understood. Attempts to treat schizophrenia with anti-inflammatory drugs have had mixed results, for instance, and as Raison found with depression, there may be pockets of people who respond better to these

Inflamed in the brain

Target the immune system to treat Alzheimer's

The inflammatory response, which is designed to keep us safe when we get sick, might lie behind some cases of depression (see main story). But it is also thought to play a role in the death of cells associated with neurodegenerative conditions such as Alzheimer's disease.

The brain is protected from the body's aggressive immune system by the blood-brain barrier, but has its own immune cells that can be activated by signals from the body's inflammatory response.

Hugh Perry, a neuroimmunologist at Southampton University, UK, suspects that immune cells in the brain called microglia could be killing off neurons.

One of the many roles of microglia is to scavenge debris from the brain. Perry's theory is that microglia are activated by characteristic deposits of amyloid protein in the brains of people with Alzheimer's, but they struggle to remove it and so are kept in a chronically excited state.

Then, when signals of inflammation come in from the body – whether from infections, stress, or chronic disease – microglia secrete cytokines to induce sickness behaviour as they normally would. But because they are already in their activated form, they secrete them at such high concentrations that they kill surrounding neurons (see "In sickness and in health", left).

Microglia in their activated form were first spotted in the brains of people with Alzheimer's disease in the early 1980s, but many dismissed the notion that this brain inflammation was damaging. Instead, they said, the amyloid deposits were the main

cause of neuron death and the inflammation was the brain's way of trying to respond.

In the last five years, the tide has turned in favour of Perry's inflammation model. This is mainly thanks to genetic studies that have found people with the disease are more likely to have mutations in genes that keep the activity of microglia in check.

"It's almost universally accepted now that inflammation is part of the main driver of Alzheimer's," says geneticist John Hardy of University College London, who carried out some of this research.

Hardy was a sceptic who has now reconsidered his views. He still believes that the protein deposits are an important target for potential treatment, but says that inflammation could be too.

Perry along with Clive Holmes, also at Southampton, and their colleagues are now conducting trials of a drug called etanercept in people with Alzheimer's – an anti-inflammatory that is normally used to treat rheumatoid arthritis. Their preliminary research has shown that the drug was safe, and did not increase the risk of infection – an important consideration when giving elderly individuals a drug that suppresses their immune system. There were also hints that the treatment helped with some symptoms, including poor memory.

In the next few months, Holmes plans to run a follow-on study in which his team will measure the direct effect of this treatment on inflammation in the brain. The ultimate aim is a bigger trial with a sufficient number of participants to specifically test clinical outcomes such as cognitive decline.

drugs than others. There are also other complications, including the risks of prolonged treatment with powerful anti-inflammatories that suppress the immune system.

Even so, for Pariante, the ramifications of the idea that depression might be caused, and treated, in much the same way as allergies and asthma, are seismic. "Suddenly it brings depression into the context of just another

"Suddenly it brings depression into the context of just another medical disorder"

medical disorder," he says. That might help overcome the stigma and discrimination that is thought to deter half of people with depression from seeking treatment.

Knowing that inflammation plays a role in mental health also means we can all take steps to buffer ourselves from its effects. Obesity, smoking, inactivity, and a poor diet can all increase inflammation. Conversely, regular exercise and a diet rich in omega-3 oils and wholegrains have all been shown to reduce it. Many studies have reinforced the link between unhealthy lifestyles, chronic inflammatory conditions such as obesity, and depression. And the link between obesity and Alzheimer's has led some to call it a kind of "brain diabetes".

"It's not just about hoping that pharmaceutical companies are going to pop up with a drug that's going to fix things," says Hugh Perry, a neuroimmunologist at Southampton University, UK. "We've known it for some time: healthy body, healthy mind." One person paying attention is Mike. "I'm still a little overweight but I'm changing my lifestyle and am trying to eat better," he says.

As well as adopting a healthy lifestyle, more than ever it might be wise to monitor inflammation and treat it when it's too high, including during pregnancy and childhood when the brain is developing fast. Blood tests for elevated cytokines might flag that it's time to unwind, or be used to identify people at high risk of suicide. Pariante's vision is that in 10 years' time, you might go to the doctor, have a blood test for inflammation, and walk out with an effective treatment. "This would be a huge leap for psychiatry," he says. ■



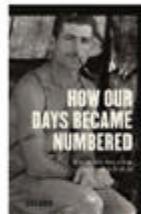
ROBERT CARTER

Dara Mohammadi is a freelance writer based in London

Nation of hypochondriacs

Life, death and racism got tangled up in big data's first outing, finds **Jonathon Keats**

How Our Days Became Numbered: Risk and the rise of the statistical individual by Dan Bouk, University of Chicago Press, \$40/£28



WHENEVER Frederick Hoffman visited the US South, one of his first concerns was sanitation. He also asked locals how often they washed

and if they ever caught colds. Once Hoffman's questions were answered, he would trek to the town cemetery with a typewriter on which he would record deaths.

He was no hypochondriac, but an actuary who worked for the Prudential Insurance Company using mortality rates to set life-insurance premiums – and he took it very seriously. From 1901 to 1921, Hoffman filled a large library with records, including dates of birth and death from 100,000 gravestones.

As Dan Bouk explains in *How Our Days Became Numbered*, the Prudential funded Hoffman's expeditions because these records hardly existed before actuaries gathered them. Life insurers pondered the lives of ordinary people more than any other institution during the period of America's industrialisation. In this history, Bouk sees the emergence of "numbered" lives, foreshadowing big data.

For life insurers, success has always depended on data about life and death, and as collection improved, companies thrived. Actuaries could predict how long clients were likely to live, and could price insurance policies so that companies paid out less than they took in. The earliest



predictions were based simply on age, but over time Hoffman and his colleagues found hundreds of other factors – some troubling, but none more divisive than race.

In 1881, Prudential actuaries determined that black people died earlier than whites. So although black and white workers alike paid a premium of 5 cents a week, families of the former were

By 1907, life insurers recognised the risks of obesity, revealing optimal ratios of weight to height"

offered only two-thirds of the payout that whites received. Other companies followed suit, provoking a backlash as black activists "fought life insurers over the relevance of history to their race's future", says Bouk. Optimistic that their civil war victory had fundamentally changed black people's fate, the activists challenged the core belief

in the predictive power of the past.

As Bouk documents, blacks won in state legislatures, which banned racial discrimination in payouts, but ended up losing the chance to buy life insurance at all from most companies. Conceding that the civil war was a rupture, Hoffman and his colleagues decreed, unscientifically, that emancipated blacks were uninsurable.

But insurance could also heal society. "Unsatisfied with predicting the future," writes Bouk, life insurance statisticians "set out to change it" – through preventive medicine, especially once they realised that extending lives increased the time clients had to pay into the system.

The data that insurers collected proved invaluable. For example, by 1907, they recognised the risks of obesity, revealing optimal ratios of weight to height. And by 1913, they pioneered the annual check-up.

Yet even the boon to public health had a downside, as most

Racial profiling threatens a return to statistics-based discrimination

people examined were judged medically defective. The statistical onslaught of insurers, writes Bouk "helped precipitate a broadened... health crisis, or, in another sense, helped invent one". The US became a hypochondriac nation.

Bouk sees resonance both in the contemporary African-American experience and in the mania for diagnosis. Discrimination based on statistics has returned in the form of racial profiling, and personal genomics threatens to overwhelm our lives with new sicknesses and treatments.

Bouk has no advice about the responsible use of an ever-growing data hoard, but this fascinating history should teach us not to be fatalistic. Big data is what we choose to make it. ■

Jonathon Keats is an experimental philosopher and conceptual artist

When justice goes wrong

How far can science stop inequity in our legal systems? **Michael Bond** explores a must-read

Unfair: The new science of criminal injustice by Adam Benforado, Crown Publishers, \$26



THE criminal justice system is flawed. Many of its key assumptions about human nature lack evidence. Deep-set prejudices make it hard for some defendants to get a fair trial. False confessions are rife. Lawyers are no more honest than anyone else, and judges no less susceptible to bias. Juries often make terrible decisions. Too many cases ride on expert testimony that jurors and judges are ill-equipped to understand.

So says Adam Benforado, in his provocative book *Unfair*. His criticisms are not new. The usual response from the legal profession is that the system is the best it can be, and a notable improvement on such previous incarnations as summary justice and vigilantism. But Benforado, an associate professor of law and former lawyer, thinks we could do a lot better – by bringing behavioural science into the mix.

In *Unfair*, he argues that most errors in criminal justice stem from the failure to take into account the frailties of human cognition, memory and decision-making. “We think we understand the factors that determine whether a cop draws his gun, where police departments and prosecutors allocate precious resources, how high a judge sets bail, and if legislators pass a tough new crime bill,” he writes. “But a

growing body of scientific evidence suggests that we are not the consistent, rational number-crunchers that we suppose.”

As well as being a legal scholar, Benforado is well versed in behavioural science: the two disciplines meet in many of his papers. Much of the psychological research he presents has been documented, including Stanley Milgram’s obedience experiments and Daniel Kahneman’s studies on heuristics. But the implications for justice are less well known, and are shocking.

Consider, for example, that the police interrogation technique most commonly used in the US amounts to coercion and has led to numerous false confessions; that even with training, police officers are no better at spotting deception than anyone else; that

the behavioural cues that jurors are encouraged to monitor in defendants for signs of guilt are largely meaningless; and that the lack of diversity among judges – in gender, race, background and political orientation – has resulted in a dangerously constricted notion of right and wrong.

Benforado’s solutions are radical. He recommends banning all procedures known to be troublesome, such as in-court

“The author favours replacing live trials with virtual courts where participants use avatars”

identification line-ups (easily corrupted) and expert witnesses loyal to one side (he would make them all independent, funded by both parties). He also favours

disposing of live trials, replacing them with virtual environments where participants interact using avatars. “When you don’t know if a defendant is black or white, slim or obese, old or young, attractive or unattractive, it is far less likely that biases grounded in these interpersonal differences will exert an influence.”

Does he expect too much from science? He is occasionally over-eager to apply laboratory findings to real-world situations. For instance, he proposes using fMRI to screen jurors for inherent biases towards certain groups, even though there is much disagreement among researchers about whether fMRI could do any such thing, and recent research shows that biases do not affect perception as strongly as is commonly supposed.

And some of his arguments end up spiralling beyond the orbit of both science and law. How can we legally resolve the insight, from social psychology research, that a person’s decision to commit a crime is partly determined by psychological and situational influences beyond their control? Unsurprisingly, he leaves that hanging.

Yet this is a book everyone in the legal profession should read, and the rest of us too, for it is as much about the confounding idiosyncrasies of everyday behaviour as inequity in law. “The main enemy of justice does not lie in the corrupt dispositions of a few bigoted cops, stupid jurors, or egotistical judges,” Benforado says. “It is found inside the mind of each of us.” ■

Prejudice often stands in the way of a fair trial. Can we do better?



DOUG DUBOIS/IMAGES/GETTY IMAGES

Michael Bond is a consultant for *New Scientist*

A knotty tale

In an urban, climate-changed world, saving birds is tough going, finds **Bob Holmes**

The Narrow Edge: A tiny bird, an ancient crab, and an epic journey by Deborah Cramer, Yale University Press, \$28/£20

Project Puffin: The improbable quest to bring a beloved seabird back to Egg Rock by Stephen W. Kress and Derrick Z. Jackson, Yale University Press, \$30

THESE days most books about wildlife conservation must find a precarious balance between hope and despair. Here are two that teeter in opposite directions, while telling remarkably parallel stories.

In *The Narrow Edge*, science writer Deborah Cramer follows the astonishing annual journey of the red knot, a tiny shorebird, from Tierra del Fuego at South America's southernmost tip to its breeding grounds in Canada's high Arctic. Populations of knots have declined so dramatically that they were recently listed as threatened under the US Endangered Species Act.

Cramer visits key stopovers on the route, where the knots pause to refuel – sometimes doubling their weight in a few frantic weeks of feeding before flying nonstop for thousands of kilometres. At each stopover, she tells a tale of loss, using historical accounts to contrast the former abundance of knots, and of many other species, with their sadly diminished state.

Life is harder now for the knots, with urbanisation claiming some beaches and oil spills others. In Delaware Bay, for example, a century of overharvesting horseshoe crabs means vastly fewer of their eggs – a very rich food source – are available for the knots. And as climate change warms the Arctic, knots face more predators, clouds of mosquitoes



JOE MCDONALD/CORBIS

and changing weather.

Cramer's book is also about the dedicated conservationists who work to preserve each rung on the migratory ladder. Cramer spends weeks with them, walking lonely beaches and observing the birds. And she celebrates their successes, limited though they are.

The knots' tale is fascinating, but Cramer's style requires a lot of patience. Each paragraph is clear and readable, but she takes a haphazard, meandering route

"At key stopovers, the knots refuel, sometimes doubling their weight in frantic weeks of feeding"

through the rich information. Do we really need a chapter on the medical uses of horseshoe crabs' blood when the point is simply that there is a heavy demand for the crabs? Even so, readers who stick with her will find Cramer eventually fills in the whole

picture in vivid colour.

In contrast, *Project Puffin* is mostly a good-news story about Stephen Kress's 40-year effort to restore a colony of puffins to a small rocky island off the coast of Maine. In the early 1970s, no one had successfully brought back a seabird colony from extinction. Kress describes his efforts in meticulous detail, as he and his fellow puffineers – mostly interns at an Audubon Society summer camp – take puffin chicks from a large colony in Newfoundland and move them to Eastern Egg Rock in the Gulf of Maine.

Readers who love the nitty-gritty of conservation will get a good flavour of it here. Kress recounts how he built puffin burrows, drove off predatory black-backed gulls with shotguns and poisoned them with "death sandwiches", and how many times his crew almost drowned in boating disasters. But persistence paid off: today, Eastern Egg Rock

Overharvesting horseshoe crab eggs reduces a vital food for knots

supports more than a hundred nesting puffins and nearly 7000 other seabirds.

Still, readers may wonder why he bothered. Puffins are far from endangered, and large colonies exist just a short journey to the north. Was it worth his time and effort to merely extend the range of a common species a little bit?

In the final chapters, Kress makes clear that the answer is yes. The feat taught him to use decoys, mirrors and sound recordings to trick puffins into thinking they were joining an established colony. These techniques have since proven successful in restoring other endangered seabirds, including the world's rarest, the Chinese crested tern. Project Puffin has gone global. ■

Bob Holmes is a consultant for *New Scientist*

Laboratory for lease

A modern biomedical research facility which is fully fitted out and ready for immediate occupation is offered for lease



This facility contains a Certified Physical Containment level 2 laboratory (PC2), including separate tissue culture room, dark room, equipment room, consumables storage room, freezer room (with supplemental air conditioning and data ports) and isotope laboratory, two Physical Containment level 3 (PC3) laboratories, two chemistry laboratories containing a total of 24 chemical fume cupboards which are ideal for chemical synthesis, a built-in vented chemicals' cupboard and accommodation for a substantial number of free standing vented chemicals/solvents' cupboards. Also, the complex contains three analytical chemistry laboratories and a storage room. All finishes are of high quality and laboratory services include 3 phase power, reticulated low pressure gases (carbon dioxide, nitrogen and argon), high pressure nitrogen (suitable for analytical equipment), nitrogen generator, chilled water loop and independent air handling, as well as a ground floor flammable storage room, gases storage room and secure chemicals and biological waste areas. Additionally, the laboratories are serviced by ample safety stations including safety showers/eye washes,

a wash-up area, a substantial number of storage cupboards and a goods' receiving/shipping area including a goods' lift. Fire sprinklers and appropriate gas safety monitoring systems are fitted throughout.

The remaining part of the building contains 2 boardrooms which open to one large area, 31 offices, 58 work stations, 2 interview rooms, 2 meeting rooms and a large tea room, all fully furnished. A reception area and of the 65 car parks, 45 are undercover and completely secured.

The laboratory is located at 585 Blackburn Road Notting Hill within the Monash Technology Precinct, Melbourne, Australia. A rent of A\$550,000 pa plus outgoings is requested.

Contact our Agent

Lynton Williams
T 0411 330 217
E LWilliams@savills.com.au



For more information, please refer to: laboratoryforlease.com



Unleashing Human Potential



NewLink Genetics is a biopharmaceutical company focused on discovering, developing and commercializing novel immuno-oncology products to improve treatment options for patients with cancer. NewLink's portfolio includes biologic and small molecule immunotherapy product candidates intended to treat a wide range of oncology indications.

NewLink's product candidates are designed to harness multiple components of the immune system to combat cancer without significant incremental toxicity, either as a monotherapy or in combination with other treatment regimens.

NewLink is currently searching for a **Senior Scientist** to lead activities to analyze pre-clinical and clinical samples and elucidate the effector pathways of NewLink's scientific portfolio.

For more information on this and other great career opportunities, please visit our Career Page at:

www.newlinkgenetics.com/careers

NewLink Genetics is an Equal Opportunity/Affirmative Action employer. We provide equal employment opportunities to all qualified employees and applicants for employment without regard to race, religion, sex, age, marital status, national origin, sexual orientation, citizenship status, veteran status, disability or any other legally protected status. We prohibit discrimination in decisions concerning recruitment, hiring, compensation, benefits, training, termination, promotions, or any other condition of employment or career development.

Caltech

Part-time Lecturer in Scientific Written and Oral Communication for Undergraduate Biology and Biological Engineering Students at the California Institute of Technology (Caltech), Pasadena, California

Job Summary:

The Division of Biology and Biological Engineering at the California Institute of Technology seeks a part-time Lecturer to teach an undergraduate course to biology majors on written and oral communication in the field of biology. This course, taken by most Caltech biology and biological engineering majors, offers instruction and practice in writing and speaking relevant to professional biological scientists and engineers working in research, teaching and/or medical careers. The course is 6 units (3-0-3) on Caltech's scale of 1-9 unit courses, requiring 3 instructional hours per week and 3 hours of homework for students. This position will initially entail teaching one section of this course Fall Term 2015 (September 28, 2015 – December 11, 2015) and another Spring Term 2016 (March 28, 2016 – June 10, 2016).

Basic Qualifications:

- Bachelor's Degree
- Experience designing and implementing lessons on scientific written and oral communication in a classroom or lab environment.
- Experience creating and responding to written and oral communication assignments in biology and/or engineering.
- Commitment to excellence in teaching.
- Ability to communicate effectively both verbally and in writing.

Preferred Qualifications:

- Advanced degree and/or significant work towards such a degree in Biology or a biology-related field.
- A successful record of publication and conference presentations in biology.
- Familiarity with or training in "writing in the disciplines" pedagogy and theory.

Pay Status: Competitive salary with benefits.

Required Applicant Documents: CV; a cover letter explaining your interest in the position and relevant experience in working with student writers; writing sample; names and contact information for three references.

Submit Applications to:

<https://applications.caltech.edu/job/scientificwritinglecturer>

Position open until filled. Applications received by **June 30, 2015**, will be assured full consideration.

We are an equal opportunity employer and all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, or national origin, disability status, protected veteran status, or any other characteristic protected by law.

Cancer Prevention Fellowship Program



The National Cancer Institute (NCI) Cancer Prevention Fellowship Program (CPFP) is now accepting applications for Cancer Prevention Fellows. This is a unique postdoctoral training opportunity for scientists and clinicians in the fields of cancer prevention and control.

As part of the program, fellows receive:

- The opportunity to obtain an M.P.H. degree at an accredited university during the first year, followed by mentored research with investigators at the NCI. Research opportunities exist across the spectrum of cancer prevention research, including: epidemiology, biostatistics, clinical services, laboratory, social and behavioral sciences and engineering.
- Competitive stipends, paid health insurance, reimbursement for moving expenses, and a travel allowance to attend scholarly meetings or training.

The typical duration in the CPFP is 4 years (year 1: master's degree; years 2-4: NCI Summer Curriculum in Cancer Prevention and mentored research).

Applicants should meet the following eligibility criteria:

- Possess an M.D., Ph.D., J.D., or other doctoral degree in a related discipline or must be enrolled in an accredited doctoral degree program and fulfill all degree requirements by June 2016.
- Be a citizen or permanent resident of the United States at the time of application.
- Have no more than five years relevant postdoctoral experience.

The application deadline is August 25, 2015. To be considered, individuals must submit application via the CPFP website (<https://cpfp.cancer.gov/>)

To learn more about eligibility requirements and to apply, please visit our website
<https://cpfp.cancer.gov/>

If you have specific questions, please contact cpfpcoordinator@mail.nih.gov



Annual Biomedical Research Conference for Minority Students (ABRCMS)

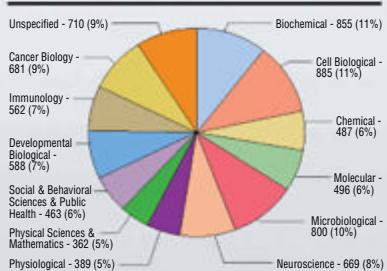
Washington State Convention Center • Seattle, WA • November 11-14, 2015



ABRCMS advances undergraduates and postbaccalaureates from underrepresented populations, including those with disabilities, in science, technology, engineering and mathematics (STEM) along the path toward graduate-level training. The conference features 1,700 poster and oral presentations, scientific sessions, professional development and networking sessions, and approximately 325 exhibit booths showcasing summer research and graduate school opportunities.

"Attending and winning in my category was one of the best experiences in my scientific life. Coming from my background, I doubted myself in the past. I now feel confident because when I presented my poster I left like I belonged. This conference really made me believe that I can pursue a career in science." STUDENT

2014 Distribution of Scientific Disciplines



Important Deadlines

Abstract Submission: **September 11, 2015**

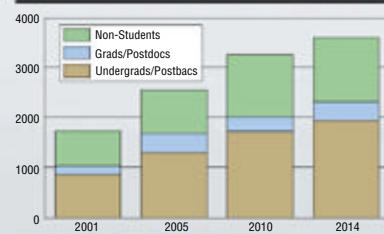
Travel Award Application: **September 11, 2015**

Judges' Travel Subsidy Application: **September 25, 2015**

Discount Registration: **October 19, 2015**

For more information, please visit: www.abrcms.org.

ABRCMS Registration



Biodomain Researcher



Purpose

Candidates are sought to fill a scientist position in Shell's Biofuels Research and Development program. The program is focused on delivering Next Generation Biofuels into the market, primarily from ligno-cellulosic feedstocks, by both biological and thermochemical routes.

Role Accountabilities

The role will be based in Shell's Projects & Technology Group, located in the Shell Technology Center, Houston, Texas. The successful candidate will work within Shell's in-house Microbial Biofuels team, scaling-up Shell's proprietary ligno-cellulosic biofuel process from the bench to production scale. The challenges in such a process range from soil carbon and ecosystem services analysis, through enzyme hydrolysis, solid and liquid phase fermentation, to molecular microbiological transformations.

Potential candidates will be engaged in a range of activities such as: ecosystem service modelling, molecular transformation, microbial pathway evolution, enzyme hydrolysis, novel fermentation, and organism research.

Responsibilities will include: design and implementation of experimental programs aimed at producing commercially viable biofuels from micro-organisms, taking into account a wide range of contributory factors; and identifying opportunities and engaging with the development of commercial plans.

Candidates are expected to have excellent intellectual and analytical ability, the enthusiasm to progress their insights, strong teamwork and leadership skills, as well as the ability to broaden outside of their area of expertise. The successful candidate will be expected to work with Shell engineers globally, as well as with external partners.

Required Qualifications/Skills

Ideally, the successful candidate will have a PhD (or be in their final year/write-up of a PhD) in one of the following areas, or a related field:

- Microbiology
- Biochemistry
- Environmental Microbiology

They will have demonstrated a willingness to learn and apply cross-discipline approaches to solving problems, and be happy working in a tight-knit team.

Experience in one or more of the following areas would be a distinct advantage:

- Soil carbon pathways and sequestration
- Metabolic pathway improvement via transformation
- Enzyme hydrolysis
- Solid or liquid fermentation (batch or continuous flow at pilot scale)

Application Requirements

- To be eligible for Graduate full-time opportunities, you should be in your final year of study or have less than three years of work experience.
- You must have a minimum Cumulative GPA (CGPA) of 3.20.
- Candidates for regular U.S. positions must be a U.S. citizen or national, an alien admitted as permanent resident, refugee, asylee, temporary resident, or an individual who possesses valid work authorization. Individuals with temporary visas (H-1, H-2, J-1, F-1, etc.) or who require sponsorship for work authorization now or in the future are not eligible for hire.

How to Apply

- In order to be considered for this position you must apply online at www.shell.us/careers.
- In the "Students and Graduates" section, click on "Shell Recruitment Day" and then create an account. When entering your contact details, select "Other" in response to "Where you found out about this Shell opportunity," click "Next" and then type in "Biodomain Researcher."
- We require a completed application, an updated copy of your résumé and an unofficial copy of your transcripts / grade report prior to be considered for an interview.

You &
Kids &
Finding
the
answers



Here, success is measured in discoveries made, processes perfected, and technologies advanced. In major medical breakthroughs and small acts of kindness. And in colleagues who have your back and patients who have your heart. As the teaching hospital of Harvard Medical School, our reach is global and our impact is profound. Join our acclaimed research team and realize your greatest goals in an environment as committed to research and technology as we are to the lives it changes.



Explore research careers.
bostonchildrens.org/jobs

SANFORD[®] RESEARCH

Sanford Research, located in Sioux Falls, South Dakota, is currently seeking a full-time **Postdoctoral Fellow** for the Chandrasekar Lab.

The Chandrasekar lab investigates the role of actin associated proteins in cell and organ function. We study membrane trafficking and endocytic mechanisms in organ specific cell types and how actin cytoskeleton regulates this process. We use cell culture methods along with advanced imaging techniques to address some fundamental cell biology questions and extend these findings to organ function in mouse models.

We are seeking highly motivated individuals with excellent problem solving skills. The ideal candidate will have a Ph.D. in molecular cell biology or related field, with some experience in microscopy/imaging techniques. Training in mouse models and mouse genetics will be provided. The position should be of interest to young scientists who want to apply cutting edge microscopy techniques and mouse genetics to study basic cell and organ biology and relate the findings to human diseases.

To view a full job description and to apply, visit careers.sanfordhealth.org and reference job #231067.

EOE/AA

POSTDOCTORAL OPPORTUNITIES

Find these and many more postdoctoral opportunities on our New Scientist Jobs online jobs board!

Go to www.NewScientistJobs.com

Enter the Job ID# listed below to read about the position. Find more jobs by entering your criteria into the grey search box.

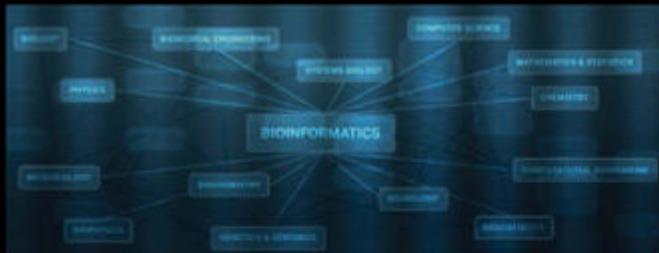
1401572997 POST-DOCTORAL RESEARCH PROGRAM (ORD) - **United States Environmental Protection Agency (US EPA)**
 1401574456 Intelligence Community Postdoctoral Research Fellowship Program- **Oak Ridge Associated Universities -USA**
 1401546598 NASA Postdoctoral Program (NPP) Oak Ridge Associated Universities - **NASA Postdoctoral Program**
 1401556261 Postdoctoral Research Associate in MicroBooNE and Mu2e, Kansas State University - Manhattan, KS **Kansas State University, Department of Physics**
 1401570665 Postdoctoral Research Associate - **Kansas State University, Department of Physics**
 1401571171 Research Associate, Physics - **Kansas State University, Department of Physics**
 1401567298 Part time Post Doc or PHD student, NY, NY, can supplement current salary, at 100.00 per hour... **University of California, Los Angeles (UCLA)**
 1401546596 Postdoctoral Positions - Birmingham, AL **University of Alabama at Birmingham (UAB), Office of Postdoctoral Education**
 1401545856 Faculty and Postdoc Opportunities - Irvine, CA **University of California, Irvine**
 1401571777 Postdoctoral research fellow in immunology/vaccinology **National Institute of Allergy and Infectious Diseases (NIAID), National Institute of Health (NIH)**
 1401576142 Cancer Prevention Fellowship Program - Bethesda, MD **National Cancer Institute (NCI), National Institutes of Health (NIH)**
 1401571023 Staff Scientist, Cancer- Memphis, TN **St. Jude Children's Research Hospital**
 1401576263 Post Doctoral Research Fellow Immunobioengineering **Fred Hutch**
 1401576262 Post Doctoral Research Fellow Statistical Methods Development **Fred Hutch**
 1401576255 Post Doctoral Research Fellow Patient Genomics Data Visualization **Fred Hutch**
 1401576246 Post Doctoral Research Fellow **Fred Hutch**
 1401576225 Post Doctoral Research Fellow B Cell Response to Vaccination **Fred Hutch**
 1401576175 Statistical Research Associate I III **Fred Hutch**
 1401564440 Bioinformatics Post-Doctoral Fellow, Bioinformatics Group - **Children's Hospital of Philadelphia and the Center for Childhood Cancer Research (CCCR)**
 1401573112 Postdoctoral Position - Boston, MA **Boston Children's Hospital and Harvard Medical School**
 1401568409 Research Fellow, Gene Expression- Boston, MA **Dana-Farber Cancer Institute**
 1401566941 Postdoctoral Positions - Cancer Stem Cell Biology Laboratory - New York, NY **Weill Cornell Medical College**
 1401574581 Research Fellow - Cincinnati, Ohio, US **Cincinnati Children's Hospital Medical Center (CCHMC)**
 1401574557 Postdoctoral Research Fellow Position - Cincinnati, Ohio **Cincinnati Children's Hospital Medical Center (CCHMC)**
 1401574565 Postdoctoral Fellow - Division of Immunobiology - **Cincinnati, Ohio, US Cincinnati Children's Hospital Medical Center (CCHMC)**
 1401572076 Postdoctoral Research Fellow, Pediatric Ophthalmology - **Cincinnati, OH Cincinnati Children's Hospital Medical Center (CCHMC)**
 1401572075 Postdoctoral Research Fellow, Autoimmune Genomics and Etiology - **Cincinnati, OH Cincinnati Children's Hospital Medical Center (CCHMC)**
 1401577016 NIH T32 Postdoctoral Training Program in Clinical Pharmacology - **Cincinnati, OH Cincinnati Children's Hospital Medical Center (CCHMC)**
 1401569759 Postdoctoral Fellow for the Chandrasekar Lab **Sanford Health**
 1401577063 Postdoctoral Fellow **University of Colorado Denver Anschutz Medical Campus**
 1401575480 Post Doctoral Opportunity - Oncology NGS Bioinformatics, USA **AstraZeneca US**
 1401575899 Post Doctoral Opportunity - Neuroscience, USA **AstraZeneca US**
 1401575782 Post-Doctoral Researcher, Tumor metabolism (61422) **EMD**
 1401574458 Clinical Research Associate - Bethesda, MD **Sucampo Pharmaceuticals, Inc**
 1401546595 Grant Programs for Scientific Research and Teaching - **Burroughs Wellcome Fund**



Print Digital Mobile


NewScientist Jobs

MS in Bioinformatics at Boston University



One of the first programs of its kind, the Bioinformatics Graduate Program offers unique interdisciplinary training in the science, engineering, medicine and ethics of twenty-first century cell biology.

Now awarding MS Merit Scholarships,
providing tuition assistance to full-time
students on a competitive basis

The Master's degree requires a total of 32 credits. You can complete the program in as little as 18 months, or enroll part-time for a schedule that fits your lifestyle. BU Bioinformatics offers an MS degree in Bioinformatics, or an MS in Bioinformatics with a focus on Translational Medicine

Application Deadlines:
July 1 for fall | December 15 for spring

bu.edu/bioinformatics/

**BOSTON
UNIVERSITY**

UNITED STATES ENVIRONMENTAL
PROTECTION AGENCY
Office of Research and Development

POST-DOCTORAL RESEARCH PROGRAM RESEARCH THAT MAKES A DIFFERENCE IN THE WORLD

The Office of Research and Development (ORD) of the United States Environmental Protection Agency is accepting applications beginning May 4, 2015 through June 8, 2015 for approximately 37 federal, three-year post-doctoral research positions.

HIGH PRIORITY RESEARCH OPPORTUNITIES

- Research spans all levels of human and ecological health including biologic organization from the genome to populations, communities and ecosystems
- Work as part of integrated trans-disciplinary research teams that generate results that contribute to protecting human health and the environment
- Mentors are nationally renowned in their fields, with a strong interest in shaping your career
- Facilities and equipment are state of the art
- Resources are reserved for your projects... no need to write a grant!
- Voted multiple times by The Scientist Magazine as the Best Place to Work for Post-Doctoral Fellows

UNSURPASSED FEDERAL EMPLOYEE BENEFITS

- Starting salary-- **\$70,192 for new Ph.D.**; up to **\$99,760 for post-doctoral experience**
- Full **three-year** appointments
- Paid relocation to EPA duty location
- Vacation and sick leave
- Federal health benefits, life insurance, and retirement program
- Travel to professional scientific meetings
- Active Post-doctoral Trainee Organization, onsite at RTP, NC

EASY APPLICATION PROCESS – EMAIL, MAIL OR FAX US BY JUNE 8, 2015

- Up-to-date Curriculum Vitae
- Letter of recommendation from your research advisor or comparable official
- Cover letter indicating positions and locations of interest, your email address, U.S. citizenship status, and how you learned of this program
- DD-214, if claiming veteran's preference
- Preference is given to U.S. Citizens

To learn more about our current research projects and application requirements, please visit the ORD Internet site at <http://cfpub.epa.gov/ordpd/index.cfm> or contact Ms. Dorothy Carr at (800) 433-9633, or via email at ordpostdocapps@epa.gov.

The U.S. EPA is an Equal Opportunity Employer.

Where women in science shine

At AstraZeneca, we're proud to have gained a host of awards for our progressive and diverse working practices. But we are always reaching for more. Each award we receive pushes us further, and strengthens the connections between fellow employees, patients, stakeholders and the communities we serve and value.

We're committed to increasing the number of women in senior roles, highlighted by AstraZeneca being named as a top 10 company

for Executive Women in the 2014 National Association for Female Executives Awards.

This reflects our passion for nurturing and supporting the careers of women in science. Our culture is dynamic, inclusive and collaborative, and we're always looking for inspiring female leaders to contribute to the global future of science.

At AstraZeneca we believe that putting science first allows creativity and ideas to

AstraZeneca 

flourish, teams to collaborate effectively, and our people to be bold in their decision-making.

We are always looking for great people and enterprising leaders to join our team. To find a full list of opportunities, please visit our careers page at astrazenecacareers.com

An Equal Opportunity Employer Minorities/Women/Protected Veterans/Disabled/Sexual Orientation/Gender Identity.

What science can do

Oncology combination therapies

AstraZeneca is investigating combinations of biologic and small molecule therapies for the treatment of cancer. These combinations target the tumour directly and some help boost the body's own immune system to induce tumour cell death.





What's possible?

Esprit Chemist and Scientist Leadership Development Programme

Are you a **PhD-qualified chemist or scientist** eager to become a global scientific leader? Do you want to translate your expertise into disease-beating medicines and help people across the world to do more, feel better and live longer?

A science-led, patient-driven, global healthcare company, our three-year, individually tailored Esprit R&D programme in the UK or US could fast-track you into a senior leadership role within our business. High-profile, global rotations will give you in-depth drug discovery and development knowledge across a range of disciplines. You'll be learning from thought leaders in your field. And you'll benefit from unrivalled formal training, mentoring, coaching and development to enhance your leadership capabilities and standing as a chemist or scientist.

You'll need a PhD in life sciences/biomedical sciences or an aligned qualification, or a PhD in chemistry or an aligned area, plus leadership experience in the Pharmaceutical or Biotech field.

We will be open for applications from 29th June until the 15th July 2015.

Find out more about our requirements and apply at <http://www.gsk.com/en-gb/careers/postgraduates/postgraduate-esprit-randd-programme/>

Please note that candidates need to be available to attend a 2-day assessment centre on 19th/20th October 2015 in London, UK.



Call for Applications

Chair, Department of Medical Biophysics

The Schulich School of Medicine & Dentistry, at Western University, is inviting applications for the position of Chair in the Department of Medical Biophysics.

As Canada's first Department of Biophysics, the Department has grown to become one of Canada's leading centres for medical biophysics research with approximately 20 primary faculty members and over 70 actively collaborating cross appointed faculty leading internationally recognized research programs in medical imaging, microcirculation, computational modelling, biomechanics, and cancer. The department is the academic home to both undergraduate and graduate programs, including CAMPEP accreditation. It draws on a rich city-wide infrastructure incorporating two research Institutes, three hospitals, and five University Faculties. Research programs benefit from close collaborations between clinical and basic science faculty, with unique training programs in diverse fields.

The successful candidate should have a demonstrated track record of leadership and research and teaching excellence with a proven reputation for effective interpersonal and administrative skills. The new Chair will facilitate collaboration and be expected to support the research, educational and interdisciplinary initiatives of the Department. The successful candidate will build on the strength and forward momentum of the Department's graduate and undergraduate programs and promote the development of new initiatives in research, scholarship and education. He or she must have a PhD, MD, DDS or equivalent, and will receive a tenured academic appointment at the level of Associate or full Professor. Candidates with a research program complementing existing research strengths are particularly encouraged to apply. The position of Chair is for a five-year term, renewable.

Western University is located in London, Ontario, with a metropolitan census of 530,000. As Canada's 11th largest city, London boasts an extensive educational and health care community. With full time enrollment of 32,000, Western graduates students from a range of academic and professional programs. Further information about the Schulich School of Medicine & Dentistry and Western University can be found at www.schulich.uwo.ca, and <http://www.uwo.ca>. Western's Recruitment & Retention Office is available to assist in the transition of successful applications and their families. Details about the Department of Medical Biophysics can be found at <http://www.schulich.uwo.ca/biophysics/>.

Interested candidates should submit a CV outlining their research, teaching, and administrative experience and interests, including future directions, together with the names and addresses of three referees to:

Dr. Michael Strong, Dean
Schulich School of Medicine & Dentistry
Room 3701A, Clinical Skills Building
Western University
London, Ontario N6A 5C1
FAX: (519) 850-2357
selection.committee@schulich.uwo.ca

Please ensure that the form available at <http://www.uwo.ca/facultyrelations/faculty/Application-FullTime-Faculty-Position-Form.pdf> is completed and included in your application submission.

Applications will be accepted until the position is filled.
Review of applicants will begin after September 30, 2015.

Positions are subject to budget approval. Applicants should have fluent written and oral communication skills in English. All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority. Western University is committed to employment equity and diversity in the workplace and welcomes applications from all qualified individuals, including women and men, members of visible minorities, aboriginal persons, persons with disabilities, and persons of any sexual orientation or gender identity.

Women in Science

Clearly, women have come a long way from the days when they were not considered fit to do science or were discouraged from pursuing graduate degrees in the discipline. While they may have earned their place at the laboratory bench, female scientists remain greatly underrepresented in the highest ranks of academia. For instance, a recent National Science Foundation (NSF) survey found that only a little more than a fourth of the deans in colleges and universities are women. Some researchers – men and women alike – believe that equality is simply a matter of time, arguing that the increasing numbers of females going into the pipeline will push more and more of them down the line. But thus far, that theory has not held true, says Diane Halpern, a professor of psychology at Claremont McKenna College and chair of a Department of Education taskforce on encouraging more women to go into science and mathematics.

**BURROUGHS
WELLCOME
FUND** 

Dr. Halpern says plenty of women and girls are stepping onto the ladder leading to an academic career in science. Females have made up the majority of students enrolled in college for the last 25 years. But obstacles – such as family obligations and subtle yet damaging gender biases – do remain to their ascent to higher positions in academia, causing many women to stumble along the way. In the biological sciences, the NSF shows that women are earning 56 percent of the Ph.D.'s, and a slightly smaller percentage of postdoctoral fellowships. But then the numbers drop off further, as females hold just 19 percent of tenured full



professorships in science, engineering, and technology.

While overt discrimination in the United States is illegal, if not obsolete, women's abilities do continue to be underestimated and undervalued. In her book *Why So Slow? The Advancement of Women*, Virginia Valian explains that expectations of men and women in our society are different, and those expectations – "gender schemas" – skew our perceptions, even among the very scientists whose livelihood is based on their objectivity. Because of the influence of these gender schemas, the abilities and contributions of men tend to be overrated whereas those of women go underrated. A large body of research exists suggesting that each disadvantage – not getting credit for an idea, not being invited to a scientific meeting – can add up over time, so that men reach the top faster and in greater numbers than women do. As Dr. Valian later writes, "Well-meaning observers may tell the woman not to make a mountain out of a molehill. What they do not understand is that the notion of the accumulation of

advantage encapsulates. Mountains are molehills, piled one on top of the other."

Researchers have spent decades on the topic of women in science, exploring every possible explanation for why females may not choose to go into science, or do not stay there, or are not able to achieve at the highest levels once in the career. Are girls wired differently, so that verbal skills come more naturally than mathematics? Are they socialized to go into more nurturing professions? Does the burden of child-rearing get in the way of their achievement? Or is the culture of the workplace toxic to women? But one question that has not received as much attention as the rest is why it matters that there are not as many women as men in the scientific profession.

To read the complete article, visit the Burroughs Wellcome Fund site at: [NewScientistJobs.com](http://www.NewScientistJobs.com)

<http://jobs.newscientist.com/minisites/burroughs-wellcome-fund/>

EDITOR'S PICK



When microbes fight back

From Ben Haller

Engineering gut microbes to do our bidding is a fascinating and important research area (6 June, p 40). But bacteria have short generation times and large population sizes, and can therefore evolve quite rapidly if selection pressure is strong – as it is in the highly competitive environment of the human gut.

If we arm a particular bacterium to seek out and destroy, say, cholera, the weapons might end up being used in very different ways from those we intended. It is doubtful that our engineered bacteria would, in their original state, occupy a “fitness peak” in the evolutionary landscape of the gut; but if they evolved to kill off all their competitors, rather than just the ones we engineered them to kill, that might represent quite an attractive fitness peak and they might evolve towards it quite rapidly. Even if we engineer a “kill switch” to allow us to eliminate the bacterium if something goes wrong, the pressure to evolve a way to evade it would be immense.

I hate to quote Jeff Goldblum's rather silly character in *Jurassic Park*, but when he said that “life finds a way”, he did have a bit of a point. We have learned this lesson over and over; it has had an enormous impact on our treatment of HIV and AIDS. *Ithaca, New York, US*

To read more letters, visit newscientist.com/letters

Iron in the blood and the brain

From Joanna Collingwood

I was interested to read Clare Wilson's report on iron levels in the brain predicting when people will get Alzheimer's disease (23 May, p 17). A fundamental question about iron status in the cerebrospinal fluid has not yet been addressed, however, because this study measured the amount of ferritin protein, not the amount of iron bound to it.

A review by Yunlong Tao and colleagues confirmed that iron levels increase in certain regions of the brain in Alzheimer's disease, but also that iron in blood serum decreases (Journal of Alzheimer's Disease, doi.org/5fg). Meanwhile, Douglas Kell and Etheseria Pretorius argue that the ferritin level in serum is an important inflammatory marker as it is mainly a leakage product from damaged cells; strikingly this serum ferritin has lost most of its iron (Metallomics, doi.org/5fh).

I conclude that determining whether the ferritin present in cerebrospinal fluid that predicts Alzheimer's disease has retained or lost its iron will affect our understanding of iron regulation in disease and the scope for developing future treatment. *Coventry, West Midlands, UK*

Nature's way with energy storage

From Desmond Mottram

The Global Apollo Programme to persuade governments to spend a sum equivalent to the Apollo space programme on solving our energy needs is to be applauded (6 June, p 6). I do hope the programme remembers that solar energy need not be converted to electricity before it can be stored.

Nature has already cracked the problems of storing and distributing solar energy. Plants

eschew mechanical and electrical methods, using biochemistry instead: photosynthesis to capture solar energy and starches and oils to store it. Distribution is then easy.

When nature does something differently to us, we may be missing something. Looked at this way, the challenge is to discover how to use plant chemistry efficiently enough to undercut fossil fuels and not starve people of food. It would be a pity to waste £15 billion a year for 10 years going down the wrong track.

Combe Martin, Devon, UK

What is value in a cashless society?

From Paul Tavener

Jem Bendell discusses four threats looming for any cashless society (6 June, p 24). It seems that a cashless economy is already proposed in Israel, in the name of preventing money laundering and tax evasion.

I fear Bendell may have missed the biggest threat of all. If we live in a cashless society there will be nothing to stop the base interest rate being driven down well below zero in an attempt to “stimulate the economy”, since there will be no way for anyone to take money out of the system.

Waterlooville, Hampshire, UK

The price of paying for carbon offsets

From Sam Edge

Michael Le Page mentions carbon offsets for flying (30 May, p 37), but does not follow the logic through. In order to have money for the offsetting – and indeed the flights – one must normally earn it. Being employed is a carbon-generating process for most.

Those of us with the disposable income to fly and pay for the offset should instead be able to

forgo the money and the carbon emissions by working less and pursuing low-carbon pastimes. Stay at home, and go to bed when it's dark. In the day, read second-hand books or take walks and cycle rides.

Ringwood, Hampshire, UK

A selfishness tax on all consumption

From Brian Tagg

Gail Haslam Loose suggests taxing “selfish” indulgences that harm our environment to fund mending it (Letters, 30 May). But I think she picks a strange target. The effects of a handful of space tourists' joyrides are dwarfed by the steady accumulation of carbon dioxide from the everyday affairs of the ordinary millions, herself included. To cure this requires us to tax producers on the contamination wrought by their products, or to tax all users. *Taunton, Somerset, UK*

There are more fish in some waters

From Robin Welcomme

The “hydra effect”, in which a higher death rate in a particular species ultimately increases the size of its population, is of great interest to those of us studying trends in the inland fisheries community (30 May, p 28). Catches have been growing steadily since records began in the 1950s, despite increasing pressure on freshwater environments.

To a certain extent this has been explained by a “fishing-down” process in multi-species fisheries, with the progressive replacement of larger species with smaller and more productive species whose evolutionary strategies include spawning many offspring.

Nevertheless, with the increased pressures one would predict a collapse at some point

 "My Twitter feed is supposed to be filled with innate cruelty and savagery, not excitement and joy"

Zen Faulkes tweets in response to plucky little Philae's waking up (20 June, p 6)

when fishing effort is excessive. This has happened in many single-species fisheries; but complex fisheries of tropical rivers, in particular, seem to have accommodated the extra fishing and declining quality of the environment. This is perhaps another case of the hydra effect. *Stoke by Clare, Suffolk, UK*

From Derek Bolton

Peter Abrams lists a number of negative feedbacks that put the brakes on population decline: fewer predators, less disease, more resources.

But taken at face value these are ordinary negative feedbacks – they will reduce the decline caused by, say, culling, but provide no apparent reason for a paradoxical increase in numbers. If the hydra effect is real, the explanation must be more subtle.

One complication is that, both in models and reality, a "steady state" often consists of a periodic cycle. The size of a population is interpreted as the average over the cycle. At once the paradox appears less startling: culling might lower the population in one

part of the cycle while raising it in another, leading to a misleading increase in the average.

We must remember another of Abrams's points: that culling rates only a little higher than those that maximise average population tend to lead to extinction.

Sydney, Australia

hard to believe, but behaviour gives the game away.

Chichester, West Sussex, UK

Michael Slezak writes:

■ The concept of "a species" is still a matter of considerable debate. Views on dogs and wolf speciation vary, depending on which aspects researchers prioritise. Canid specialists do not expect an agreed answer any time soon.

Dogs, wolves and splitting species

From Ann Williams

Michael Slezak writes that "the dates when dogs started to be domesticated and became a different species from wolves are a matter of some controversy" (30 May, p 12). Near a wolf and dog study centre in Battle Ground, Indiana, there is a small rescue centre for dog/wolf crosses. These are popular pets in the US but are often too dangerous to keep.

Speciation is said to occur when lines cannot mate and produce healthy offspring, so it has obviously not occurred in the case of wolves and dogs. Comparing wolves and poodles, this is often

Did I train my colour vision?

From Barry Cash

The article on improving vision (23 May, p 33) reminded me of spending two years in my early 20s matching colours in a laboratory. At the medical before my next job, to doctors' surprise I could read both the numbers I should be able to see in the Ishihara colour vision test and the numbers I should not. I put this down to the two years that I spent looking intently for differences in colours.

Bristol, UK

Alright on the night without the fright?

From John Reynolds

So machines are in training to be concert virtuosos (30 May, p 21). As an amateur violinist who once worked for a software company that published a music sequencer program, I hope someone writes performance anxiety and the urge to impress into the algorithm.

These emotions, I find, can always give performances an extra human edge.

Canonbie, Dumfriesshire, UK

Vintage vinegar sought in vain

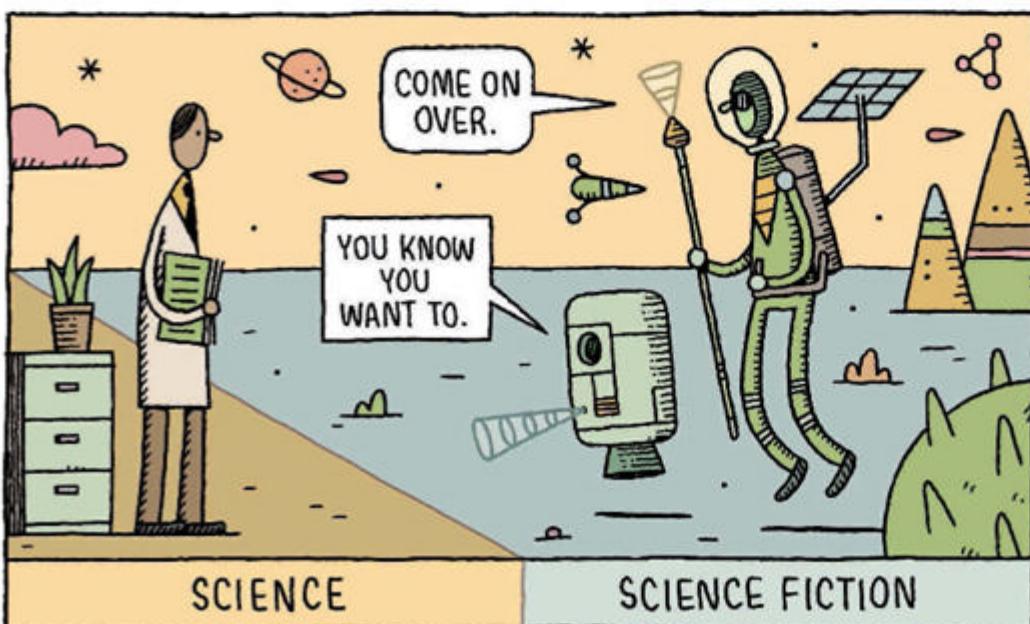
From Eric Kvaalen

You say that the grape juice in the 170-year-old champagne found in the Baltic Sea had not turned to acetic acid probably because of the cool temperatures and dark environment (25 April, p 20).

The reason the champagne had not turned to vinegar was that there was not enough oxygen. Every gram of acetic acid requires about half a gram of oxygen.

Les Essarts-le-Roi, France

TOM GAULD



For the record

■ We aimed for a star, but missed: the variable star photographed by the Hubble telescope is V838 Monocerotis (25 April, p 26).

■ We were away with the fairy circles in the deserts of Namibia, which in fact receive 50 to 100 millimetres of rain per year (13 June, p 38).

Letters should be sent to:

Letters to the Editor, New Scientist, 110 High Holborn, London WC1V 6EU
Email: letters@newscientist.com

Include your full postal address and telephone number, and a reference (issue, page number, title) to articles. We reserve the right to edit letters. Read Business Information reserves the right to use any submissions sent to the letters column of *New Scientist* magazine, in any other format.



WHAT happens to some minds that win Nobel prizes? Does the gleam of the medal embolden them to air views no one else would dare? Are they more likely to be asked questions that take them out of their comfort zones? Or are they just more likely to put their feet in their mouths?

Not very notoriously, Tim Hunt won the Nobel prize in 2001, with Paul Nurse and Leland Hartwell, for elucidating how protein molecules control cell division. Very notoriously, he told the World Conference of Science Journalists earlier this month that the “trouble with girls” in the laboratory was that “you fall in love with them, they fall in love with you and when you criticise them, they cry”.

Amid the outcry that followed, *New Scientist* consultant Debora MacKenzie assessed his argument for single-sex labs (at bit.ly/LabStorm). Clearly he hasn't thought it through logically. “Maybe lesbians can work with straight males,” Debora wrote: “But some straight males might frustratingly fall in love with lesbians. The gay guys could work with straight

women, but we all know straight women are forever falling for them.”

DEAN BURNETT, writing for *The Guardian*, also considered the case for segregated labs (bit.ly/BanOldMen). Constructing an argument at least as rigorous as Hunt's, he concluded that one group were unlikely to contribute much scientifically, while causing much commotion, and should be excluded forthwith: old men.

IT'S not just men who put their foot in it. Last month, Alice Huang, biologist, former president of the American Association for the Advancement of Science, and agony aunt for the journal *Science*, was asked by a researcher what she should do about an adviser who kept looking down her shirt.

“Imagine what life would be like if there were no individuals of the opposite – or preferred – sex. It would be pretty dull, eh?” came Huang's breezy reply, before concluding: “As long as your adviser does not move on to other advances, I suggest you put

up with it, with good humor if you can.” Readers were less than good-humoured at the advice: the article was swiftly retracted.

SOMETIMES science and non-science interact in the strangest ways. In 1956, archaeologist Marija Gimbutas published her theory that the Indo-European languages were spread by a warrior people from the steppes. She identified them by their characteristic burial mounds, called “kurgans”.

In the 1970s her theory began to attract attention from feminist scholars seeking to answer the question: how did men come to have so much power? How did a transition from the relatively egalitarian societies of many hunter-gatherer peoples happen? So far, so science.

Then, however, the theory was latched on to by those who would reinstate a presumed matriarchal religion. Not science. Indeed, Gimbutas's own last book was titled *The Civilization of the Goddess*. Mention of the Kurgan people in polite scholarly circles drew increasingly odd looks.

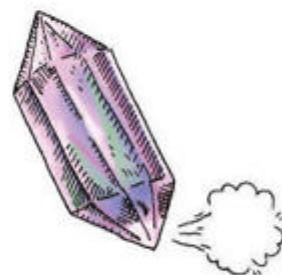
Now, a team of geneticists has sequenced Y chromosomes from 334 men across Europe. They found that two-thirds of them seem to descend from just three men who were alive between 3500 and 7300 years ago (doi.org/5ch). Daniel Zadik wrote in a blog that possibly all three were from the Yamnaya people.

Who were they? Nomadic herders and mound-builders who spread from the steppes four millennia ago. Daniel wondered how they had so many descendants and mused, “if a male elite was established with the advantages of Yamnaya culture [and] monopolised women...” Gimbutas may, in a way, have been more right than even she imagined.

A MORE recent take on falling in love and/or power relations is provided by the customer care department of dating site eHarmony, who told

Richard Eibeck: “At this time, we are no longer accepting e-mail inquiries that are submitted outside of our FAQ web form... We regret to inform you that the e-mail message that you have submitted was not received and you will not receive a response...”

THINKING of ancient Indo-European languages reminds us of the fruitloop marketing for the “Pranava Energy Activator”, promoted on the premise that “Prana is Sanskrit for ‘the Breath of the Creator’”, and that it “basically charges each crystal with a special Lifetronic Light Frequency or Prana...” (16 February 2013). Giuseppe Sollazzo says that in Bologna, Italy, “pranare” is the local word for “producing flatulence” – a fitting way to sum up such promotion.



FINALLY, Jo Abbess questions our dedication to recognising the contribution women have made to science. She notes a caption to a photo of mathematician Emmy Noether saying that she “remains largely unknown, despite her seminal work” (25 April, p 33).

We like Jo's suggestion that such founding contributions should, instead, be declared “oval”. This adjective is particularly appropriate in Emmy Noether's case, Jo says, “since she majored in rings and other topological things.”

You can send stories to Feedback by email at feedback@newscientist.com. Please include your home address. This week's and past Feedbacks can be seen on our website.

Hole number

What happens when a black hole is swallowed by another black hole?

When two black holes approach one another, they usually follow hyperbolic paths around a common focal point, so they end up galloping off in different directions.

If there are stars around, the situation becomes more complicated and the black holes can end up orbiting one another after tossing some stars away. Such an orbit will continue almost forever, unless there are still more stars nearby that can be thrown off, removing some energy and angular momentum.

A black hole may also head straight towards another, so that it would hit its event horizon. In that case, an observer would see the two black holes getting closer and closer (assuming they're visible), but would never see them coalesce. Instead, they would seem to slow down, get dimmer and the light from them would get redder. This is because their time slows down, so we might never see them reach the point at which one crosses the other's event horizon, even though that happens in due course.

*Eric Kvaalen
Les Essarts-le-Roi, France*

It is not quite as exciting as you might think. The two black holes will fuse, creating a new one with a mass equal to the two constituent masses. The surface area of a black

hole is related to its mass, so this will increase in proportion.

Because black holes are generally accompanied by an accretion disc of material that rotates around them, moving faster and faster as it spirals inwards, we can assume that the two discs will crash into one

"We can assume their two accretion discs will crash into one another before the black holes meet"

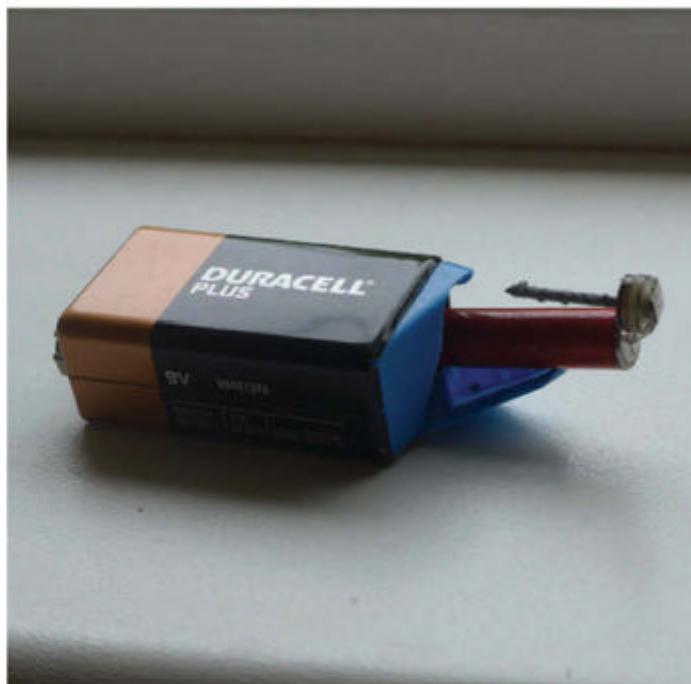
another before the holes meet. The end result will be a bigger disc, but when the two very hot discs hit each other, there will be an increase in the radiation given off until the new system settles down.

*John Anderson
Warsaw, Poland*

Insect imposter

A brilliant toddler has told me that a butterfly can't be an insect because it has more than six legs when it's a caterpillar. He's wrong, but I'm not sure why. What should I tell him?

If your young friend had turned a caterpillar upside down, he would have seen that there are in fact six fully jointed legs at the front end, just behind the head. These will become the legs of the butterfly or moth. The remaining "legs" have no joints and are really just fleshy outgrowths from the skin called prolegs. Caterpillars have up to four pairs of these, plus an extra pair



known as claspers at the tail end.

The caterpillars of geometrid moths have no prolegs, just the true legs and claspers. To move along, they have to bend themselves into a loop to bring the claspers just behind their legs, and then throw themselves forward as if measuring their own length on the ground. That explains their family name – they "measure the Earth" with this inching gait – and their popular names: "loopers" in the UK and "inchworms" in the US. Watching a looper walking

"Watching a caterpillar walking illustrates very well how useful its prolegs are"

illustrates very well how useful a caterpillar's prolegs are.

*Hazel Russman
Harrow, Middlesex, UK*

This week's question

EXPLOSIVE POWER

Last night, my wife and I were awoken by two loud cracks a second or so apart. The day after, I discovered that the 9-volt battery cell I'd removed from a fire alarm the night before appeared to have exploded (see photo). What might have caused this in a depleted cell, and why two cracks?

*David Cross
Malvern, Worcestershire, UK*

The writers of answers that are published in the magazine will receive a cheque for £25 (or US\$ equivalent). Answers should be concise. We reserve the right to edit items for clarity and style. Please include a daytime telephone number and an email address if you have one. New Scientist retains total editorial control over the published content.

Reed Business Information Ltd reserves all rights to reuse all question and answer material that has been

submitted by readers in any medium or in any format and at any time in the future.

Send questions and answers to The Last Word, New Scientist, 110 High Holborn, London WC1V 6EU, UK, by email to lastword@newscientist.com or visit www.newscientist.com/topic/lastword (please include a postal address in order to receive payment for answers). Unanswered questions can also be found at this URL.

Question Everything

The latest book of science questions: unpredictable and entertaining. Expect the unexpected

Available from booksellers and at newscientist.com/questioneverything





OLYMPUS

Your Vision, Our Future

Olympus Medical Systems

A new perspective.

What has continued to motivate us over the years? Outstanding innovation that generates new perspectives and new possibilities. In the early detection of intestinal cancer, Olympus endoscopes help doctors perform colonoscopy more gently and effectively: the very latest medical technology honed by the visionary power and expertise of a world market leader.

Discover more: anewperspective.olympus.co.uk